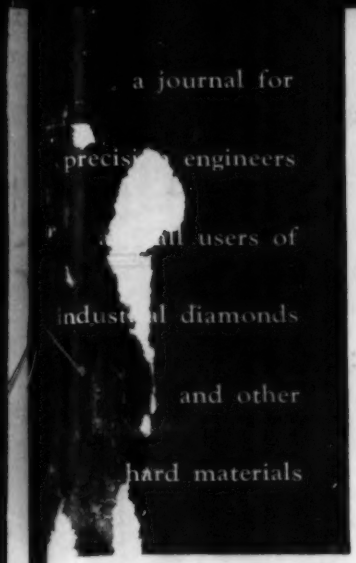

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MICROSTRUCTURES OF DIAMOND SURFACES

By S. Tolansky, D.Sc., F.R.S.

Read what the Reviewers say about this important book :—

This is a delightful book : firstly because it is a record of a piece of highly individual research by one school supervised and inspired by one man ; secondly, because it is superbly illustrated. Indeed, although the letterpress is easy to read, the ideas being clearly and simply expressed, it is probably the plates that will sell the book . . . Prof. Tolansky has developed new and very powerful optical techniques which actually reveal and enable him to measure surface steps or discontinuities of as little as 10 A., the effective useful magnification in such a case being X 500,000. . . . Cleavage, polishing, etching and sawing of diamond faces, octahedral, cubic, and dodecahedral, are all discussed in the light of really remarkable photographs, and some information is given on the difficult problem of " the two types of diamond."—Kathleen Lonsdale in " Science Progress."

Prof. Tolansky has been well served by the Goldsmiths' Press, whose wide experiences of diamond publishing has doubtless contributed to the success with which they have reproduced so many of his magnificent photographs of diamond surfaces. . . . Although all these methods are simple applications of well-known optical principles, it has remained for Prof. Tolansky to develop them into an extraordinary powerful array, needing skill to be sure, for their successful application, but comparatively little equipment beyond a good optical microscope to obtain one-dimensional resolution which compares favourably with that of the electron microscope. . . . The appearance of this book will be a welcome stimulant to many engaged in diamond research. It also provides valuable data for comparison with the artificial crystals of germanium and silicon, on which such an immense amount of effort is now being expended by the electrical industry. Since the stages of growth can actually be followed for these metals, comparative studies might well resolve some of the fascinating problems so literally brought to light by Prof. Tolansky's researches.—H. J. Grenville-Wells in " Laboratory Practice."

To those who use diamond as a tool, the information in the last two chapters, on " ring-crack " damage to diamonds, and on the surface condition of mechanically polished diamonds, should be specially worthy of study."—F. C. Franks.

Some of the traditionally accepted facts about diamond surfaces have been contradicted by Prof. Tolansky since he began studying the gem in his laboratory. His recent observations are described in " Microstructures of Diamond Surfaces." He reports, for instance, that tradition has it that diamonds have a perfect cleavage in particular directions. From optical studies of cleavage surfaces he says that " the cleavage is optically very far from perfect except in one type of diamond."—" Tooling and Production," Huebner Publications Inc.

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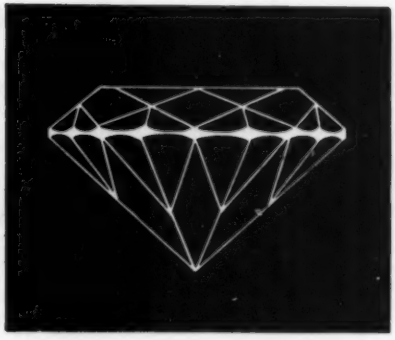

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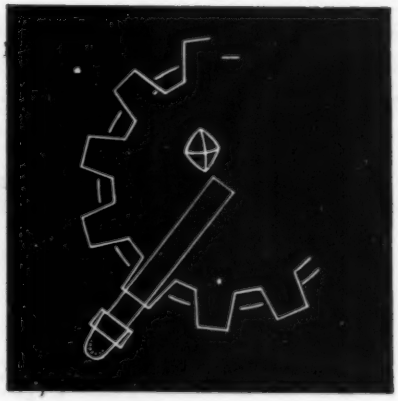

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Generally Speaking

As hard as . . . .

Quite often, claims that something or other is 'diamond hard' are seen; sometimes the claim is so far wide of the mark as to be obviously absurd, and therefore harmless, but on other occasions the material referred to really is very hard (although much less so than diamond), and in this case the description can be misleading. Two cases of this have recently come to our attention, both referring to tungsten carbide, a material whose hardness, though great, is far below that of diamond, as anyone who has ground it with a diamond wheel will know. One was in the advertising matter of a manufacturer of tungsten carbide drills for use in masonry and similar material, and referred to the bits as 'diamond hard', whilst the other was in an article in a technical journal (not published in the United Kingdom) devoted to the wire industry, and described tungsten carbide dies as being 'as hard as a diamond die'. Misleading descriptions of this sort are doubly unfortunate since, by making a purchaser think that he has got something better than he actually has, it will not only lead him to expect a better performance than he can possibly get from the item in question, and so disappoint him immediately, but may also very well disgust him with a material that, in its proper applications, or with a proper understanding of its qualities and limitations, is perfectly satisfactory.

New and Old

New processes, new techniques, new equipment—all these are being developed every day, but this activity by no means indicates that the older ways of using diamonds are being neglected. Take, for example, the simplest of all diamond tools, the glazier's diamond; a considerable amount of research has been undertaken to discover what exactly happens when a diamond cuts glass, and how and to what extent the diamond is worn in the process. Similarly,

Continued on p. 159

Factors Affecting the Efficiency of Resinoid-Bonded Diamond Wheels†

by R. G. Weavind††

Concluded from p 127

The introduction to this article was published in last month's issue of the I.D.R. This concluding instalment gives the practical details of the testing and production of the new grits.

Fig 1. Arrangement for testing grinding wheels at the Diamond Research Laboratory. On the machine in the foreground the microscope is set up to measure the amount of wear on the wheel.

Method of measuring hardness variation

Because neither the Rockwell nor the Vickers methods of hardness testing is sufficiently sensitive to show variation in the hardness of the blocks, it was decided to employ the Bergsman micro-indentation technique. In this method the depressions are only 20 micron in width, thus hardness readings can also be taken very close to the edge of the specimen. Despite the fact that the size of the depression and the grain size of the carbide are somewhat similar, the hardness readings across the specimens tested did not vary by more than four per cent.

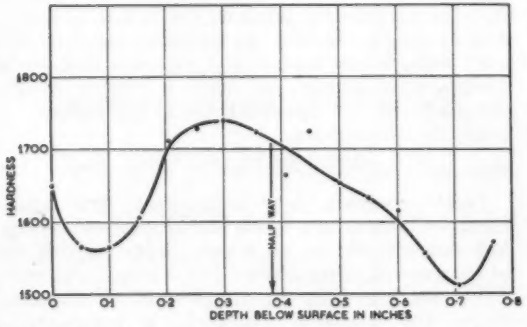


Fig 2. Variation in the internal hardness of a specimen of carbide from a South African source.

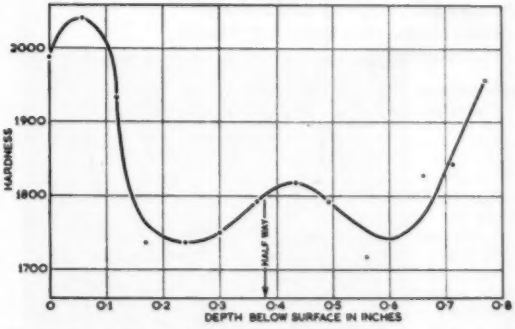


Fig 3. Variation in the internal hardness of a specimen of carbide from an American source.

Fig 2 shows graphically how the hardness varies through a piece of South African carbide, and Fig 3 shows the same detail for the American brand. It will be seen that the carbide is fairly hard on the outside, it then softens as one proceeds inwards, becomes harder in the centre, again becomes softer, to harden once more as the other side of the specimen is approached.

To ascertain the effect of these hardness variations on grinding the following test was devised.

† Paper to Industrial Diamond Association of America, Inc, at their Annual Convention held in Williamsburg, Va, in May.

†† Co-director of the Diamond Research Laboratory, Johannesburg.

Effect of hardness variation on grinding tests

A grinding wheel made with a natural diamond grit was mounted on a grinder and trued. The wheel was then worn down 0.007 in. by grinding a tungsten carbide specimen which had already been used in other tests. This was done to ensure that the surface of the wheel was in its normal condition for grinding and unaffected by the truing operation. A new specimen with only sufficient carbide removed to level the surface was then substituted and grinding continued until the wheel wore out. At every hundredth pass, the grinder was stopped and measurements taken of the wear on the wheel and the carbide.

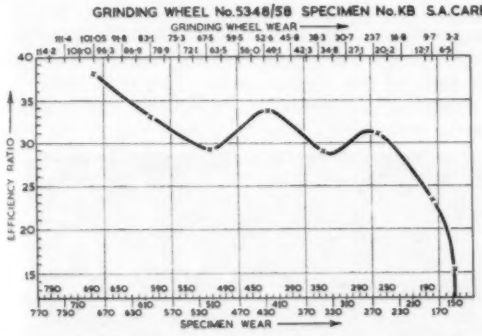


Fig 4. Grinding results on carbide from a South African source.

Fig 4 shows the results obtained on the South African carbide. The efficiency ratio is seen to drop from the outside of the specimen to the centre when it rises slightly, drops away again and then starts to rise once more as the other side of the specimen is approached. In this test the wheel wore out before the specimen, and it is interesting to note how the wheel efficiency falls away as the last 0.025 in. of resin wears down. Fig 5 shows the same results obtained on the carbide obtained from the American source, here again approximately the same pattern is seen. In this case also, the wheel wore out before the carbide and the same fall off in efficiency is apparent.

To overcome the effect of the hard skin around the carbide the Laboratory now grinds 1/10 in. off each block before commencing the test, and we also complete the tests before the last 1/10 in. is worn away.

Variation in grinding wheels

The variation in the hardness of the carbide is only one factor affecting wheel efficiency; it has also been found that there is quite a considerable variation in the grinding wheels. Already fact that any grinding results involving the last 0.025 in. of the wheel can be very misleading. Since the wheels used by the Laboratory are made with a layer of resin $\frac{1}{8}$ in. or 0.125 in. in thickness, it means that 20% of each wheel is unserviceable for accurate testing.

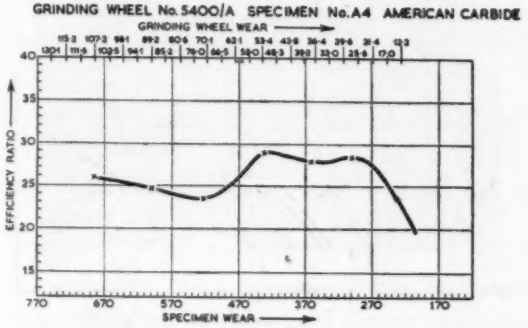


Fig 5. Grinding results on carbide from an American source.

Resin insufficiently polymerised

Another factor leading to variations in grinding efficiency was evident when a series of wheels made in an N grade of resin for the purpose of confirming a set of readings obtained previously gave very unexpected results. The efficiency ratios of the second set of wheels were very low and the wheels appeared to be soft. On examination, the resin in the second set of wheels did not have the same colour and texture as the first set, and the opinion was formed that during manufacture the resin had not polymerised to the same extent as in the first set. The wheels were accordingly submitted to a second heating cycle and again tested. The results obtained with the reheated wheels were considerably higher than those before reheating (Table II).

Effect of particle shape and surface condition in hard and soft resin

The wheels used by the Laboratory in the tests so far have been made in two grades of resin, one being harder than the other; Norton's R and N grades were used. The reason for comparing the results obtained with the two grades was to ascertain if either gave any advantage to a particular type of grit. Most of the tests undertaken so far by other laboratories on synthetic diamond have been on wheels made in a hard grade of resin.

In the tests which have been conducted on synthetic diamond grit at the Diamond Research

Laboratory, it was shown that the grade of resin employed has a marked effect on the grinding results with synthetic material, whereas the results with the type of natural diamond grit generally used in wheels are not affected to nearly the same extent. For example, a normally shaped natural

TABLE II

The effect of re-heating a resin-bonded wheel

Wheel no	Grit type	Efficiency ratio		Wheel speed (surface ft/min)
		Before re-heating	After re-heating	
5361/81	D120	17	33	5,500
5367/82	D120	23	53	5,500
5363/83	D120	15	30	5,500
5366/86	D120	23	48	5,500

grit when set in a hard grade of resin will show only 10 to 15% increase in efficiency as compared with the same grit in a softer bond. Synthetic grit on the other hand will improve by a greater percentage.

The reason for this increase is found in Fig 6, 7, 8, and 9 which show the diamond grit

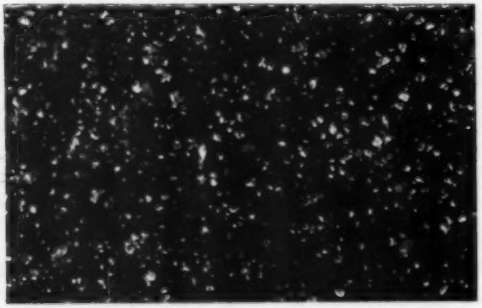


Fig 6. Diamond particles recovered from the sludge after grinding with a wheel made with a soft grade of resin containing synthetic grit.

recovered from sludge after grinding with wheels made from different types of grit. In each case the grinding wheel was run against the same grade of carbide and about 0.020 in. of the wheel was worn away, thus ensuring sufficient grit in the sludge for examination. Fig 6 and 7 show the synthetic grit recovered from the wheels made in the soft and hard grades of resin respectively, and Fig 8 and 9 show the same detail for natural diamond. Fig 10 shows the particle shape of the grit used in the wheels which contained natural diamond. Fig 10 does not represent the type of grit generally employed in resin wheels; it is

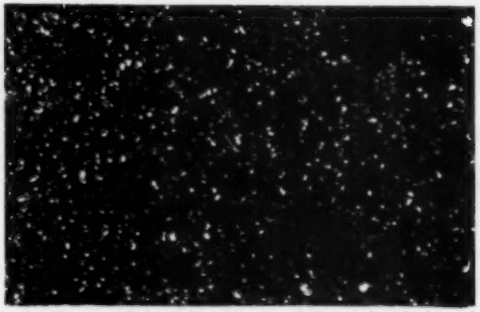


Fig 7. Diamond particles recovered from the sludge after grinding with a wheel made with a hard grade of resin containing synthetic grit.

representative of a grit which, at the time, we had found to give a grinding result about 10% better than normal for natural grit. The grit particles are magnified 25 times in the figures, the original material was ' 120 ' mesh Tyler.

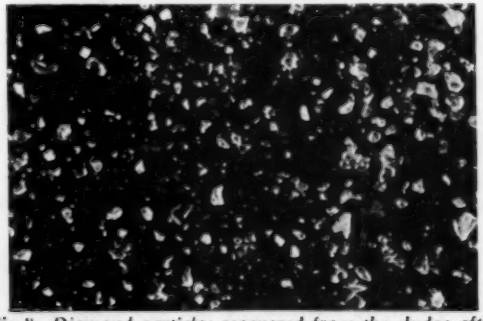
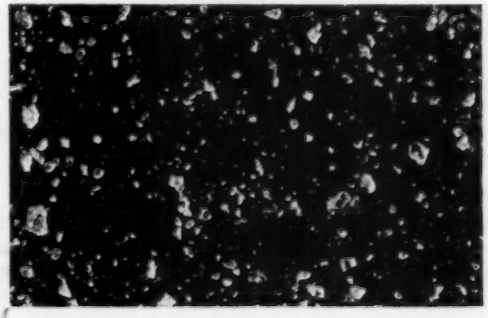


Fig 8. Diamond particles recovered from the sludge after grinding with a wheel made with a soft grade of resin containing natural grit.

As one would expect, the grit from the sludge is composed of both coarse and fine particles, but it will be seen that the grit from the natural diamond wheels (Fig 8 and 9) contains many

Fig 9. Diamond particles recovered from the sludge after grinding with a wheel made with a hard grade of resin containing natural grit.



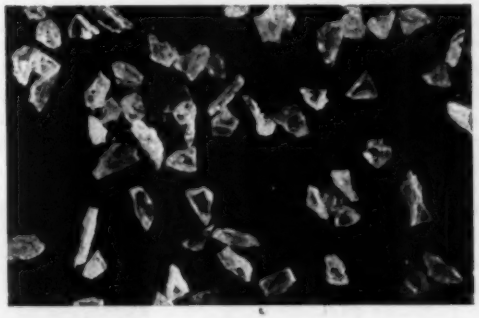
more coarse diamond particles than the synthetic grit. The great quantity of coarse diamond particles found in the sludge from the wheels containing natural grit show that a resin bond, whether soft or hard, is not able to hold efficiently the natural grit particles which have a smooth surface and a fairly regular blocky shape. It should be noted that the quantity of coarse particles in Fig 8 and 9 is approximately the same, thus indicating that there was no considerable difference in the efficiency of either wheel. In Fig 6 and 7, however, not only do both samples show considerably less coarse material than 8 and 9, but the grit in 7 is much finer than that in 6. The predominance of fines in the sludges from both the wheels containing synthetic grit indicates quite clearly that not only does the irregular shape of this material enable it to be more firmly held in the resin than the natural grit, but also that the friability of this material is such that the more firmly it is held the more it is able to break down into smaller fragments. Since the synthetic grit breaks down into small fragments instead of being dislodged in large pieces, the diamonds stay longer in the wheel.

The inference to be made from the foregoing is that if relatively friable natural diamond particles with rough or irregular surfaces were used in resin-bonded wheels, then the results obtained should be better than those with the normal type of grit employed. It can also be inferred that if the blocky particles, which are easily dislodged from the resin, could be removed from the natural grit before use, then still further improvement would be possible. The development along these lines of a special type of natural grit for use in resin-bonded wheels is dealt with in Part II of this paper.

Method of conducting grinding tests

Repeated tests in the Diamond Research Laboratory on wheels made with hard and soft grades of resin containing various types of grit have shown that neither grade has any advantage in producing consistent results. Also, due to variations in the hardness of the tungsten carbide testpieces, it is quite invalid to make a comparison between different grit types except as an average of a large number of tests. We have so far found that the only means of getting reliable results is to group say five or six wheels in a series of tests over the same number of tungsten carbide specimens. Each wheel is used to grind each specimen once in a sequence arranged so that each wheel will grind at a different level in each carbide test specimen. In the development of the special natural grits which are more suitable for use in resin-bonded wheels the above test procedure has been followed. Table III shows the system employed.

Fig 10. The shape of the particles originally set in the grinding wheels from the sludge of which the grits in Fig 8 and 9 were recovered. This is not a photograph of the type of grit which is generally employed in resin-bonded wheels.



To shorten the time and reduce the expense of the series of tests we now find necessary, the Laboratory, together with a local company manufacturing tungsten carbide, is investigating the possibility of making a carbide which will have more uniform hardness; however, a suitable material has not yet been found.

TABLE III

Method of arranging tests to overcome variation in results due to changes in hardness of tungsten carbide workpieces

Test nos	Specimen numbers				
	1	2	3	4	5
1	Wheel 1	Wheel 5	Wheel 4	Wheel 3	Wheel 2
2	Wheel 2	Wheel 1	Wheel 5	Wheel 4	Wheel 3
3	Wheel 3	Wheel 2	Wheel 1	Wheel 5	Wheel 4
4	Wheel 4	Wheel 3	Wheel 2	Wheel 1	Wheel 5
5	Wheel 5	Wheel 4	Wheel 3	Wheel 2	Wheel 1

Part II of this article starts on p 150

American IDA Elections

The Industrial Diamond Association of America, Inc, Pompton Plains, New Jersey, has elected the following officers to serve for the coming year:

D. J. Wallace (Wheel Trueing Tool Co): President
B. Jollis (US Ind Diamond Corp): First Vice-President
L. H. Metzger (Super-Cut Inc): Second Vice-President.

Directors appointed for the following two years were:

C. Baumgold (Diamond Tool Mfg Co Inc)
D. E. Stone (J. K. Smit & Sons of Michigan, Inc)
J. Taeyaerts (Precision Diamond Tool Co)
J. Van Itallie (The Van Itallie Corp).

The out-going President, M. Winston (Diamond Drill Carbon Co), will also serve as Director for the coming year.

PART II

NEW DEVELOPMENT OF A NATURAL DIAMOND GRIT ESPECIALLY FOR USE IN RESIN-BONDED WHEELS

Summary

As indicated in Part I, the efficiency of natural grit in resin-bonded wheels can be improved. The effect of particle shape, surface condition, and friability of grit has been closely studied, and the effect of these factors is discussed below. An improvement of 40% is possible with a new grit which has been developed.

Effect of diamond particle shape

When natural diamonds are crushed down to the sizes required for grinding wheels the particles produced are of all shapes, comprising blocky material, needles, and thin flat plates. It has, until recently, been thought that only blocky material should be used in wheels, whether resin-, vitreous-, or metal-bonded, and for that reason most wheel makers when preparing their grit have tried to produce this shape.

Fig 11 shows the four principal shapes of diamond particles produced in crushing; the range covers pieces with a cubic shape, rectangular pieces, needles, and flats. A very simple method of evaluating the ' Shape Index ' of a diamond grit has been evolved, and with it one can numerically express the average shape index of a mixture of particles**. For example, a shape index of 1 would indicate perfect cubes, 4 would mean all flat pieces, 2 and 3 refer to rectangular pieces and needles respectively.

A method of separating the various shapes from one another has been evolved by a member of the staff of an associated diamond company. The method enables crushed grits to be separated into blocky particles, needle-like grains, and flat platelets. This method was used to produce the different shapes of grit required in the tests.

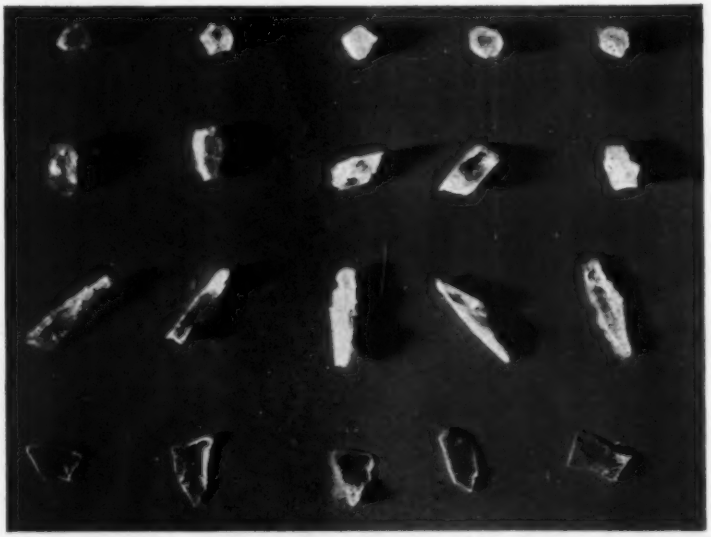


Fig 11. The four principal shapes of diamond grit produced in crushing.

A series of tests conducted by this Laboratory under conditions designed to avoid the sources of inaccurate results already described, indicate very clearly that the more blocky the particles in resin-bonded wheels the poorer will be the results. Fig 12 shows the predominance of large particles taken from the sludge after grinding with a wheel made from blocky particles, *ie* with a shape index of 2.2. The grit was specially prepared for this test by the method of separation mentioned earlier. If Fig 12 is compared with

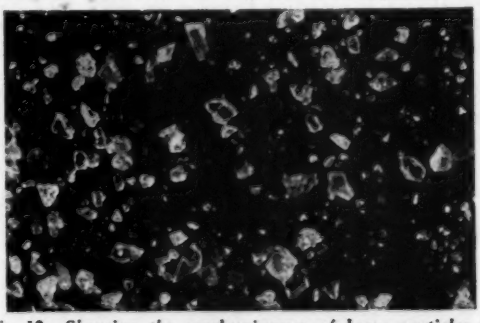


Fig 12. Showing the predominance of large particles in the grit recovered from the sludge of a resin-bonded wheel made with very blocky particles. Compare with Fig 8 and 9.

** A more accurate method than the one we have been using has recently been developed and an account of this has been published in *Industrial Diamond Review* (Apr 1959). The article is entitled 'A new method of determining the average shape of diamond and other particles', by Dr J. F. H. Custers and Dr F. A. Raal of the Diamond Research Laboratory.

either Fig 8 or 9, it will be seen that the blockier the grit the more easily are the particles dislodged from the wheels during grinding. To test the effect of the presence or absence of blocky particles in a wheel, a series of wheels was made up from blocky grit, a grit containing needle-like particles and blocks, and finally a grit from which all blocky particles had been removed. Table IV shows the average results obtained by

TABLE IV

Type of grit	Efficiency ratio	Wheel speed (surface ft/min)
Very blocky Shape factor — 2.2	14	5,500
Needles and blocks Shape factor — 3.0	22	5,500
Needles and flats Shape factor — 3.4	25	5,500

comparing wheels set with grit of various shapes, and Fig 13 shows the grit recovered from the sludge of the wheels containing needles and flat particles used in these tests. The absence of the large fragments seen in the grit from the sludge of wheels containing blocky diamond particles is very evident. Fig 13 should be compared with Fig 12.

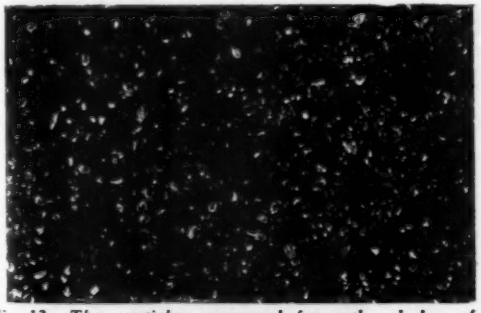


Fig 13. The particles recovered from the sludge of a resin-bonded wheel containing natural grit which has been prepared to give it a rough or irregular surface and also to cause it to break in fragments.

The friability of the grit

It has, we think, been clearly demonstrated in Part I of this paper that any advantage that synthetic grit may have in resin-bonded wheels, is due to its rough, uneven exterior and its relative friability. In this we are in complete agreement with the opinions expressed in the report of the 'Panel on Industrial Diamonds of the Materials Advisory Board'* to which earlier reference has been made in this paper. We have found that synthetic grit as supplied is so friable that the particles are reduced in size during the manufacture of the wheel ; Table V, in particular the last column, shows this point very clearly. In the report mentioned above it is also said that ' even a gentle disaggregation would have resulted in extensive breakdown in the larger grit sizes with proportionately larger percentages in the 100 mesh and other sizes '. In this case the disaggregation referred to was caused by the relatively gentle friction of the particles in a sieving process.

To overcome this deficiency, it is necessary to crush the material lightly with a pestle and mortar, thus breaking down the more friable particles and leaving a harder core better able to stand the strain of manufacture. In connexion with this statement, attention is once again drawn to the

TABLE V

	Original laboratory sieving (Tyler mesh)	Manipulation during manufacture	
		Light milling and sieving 1	Pressing 2
+100	1.6	1.4	0.9
—100+115	22.5	21.4	16.3
—115+150	20.7	20.8	20.4
—130+170	23.2	24.7	22.5
—170+200	23.5	21.3	16.7
—200+325	7.8	9.1	20.1
—325	0.8	1.3	3.2

above report, where under Annexure A, Appendix D, the following appears—' A certain amount of aggregate and dendritic grit of the ' M ' diamonds breaks down rapidly, and if these are eliminated during the primary preparation of the grit the ' M ' diamonds might perform even more efficiently '. However, if the friable portions of the grit are broken down the losses in fines will be in the region of 18 to 23% of the total quantity, thus adding not inconsiderably to the cost of the wheel, unless, of course, the fines were inserted in the wheel. In this case the efficiency of the wheel would be adversely affected.

Already indicated earlier in this paper is the fact that the more the shape of the natural grit particles approaches needles and flat platelets, then the better are they held in the resin, and the more efficiently do they operate in the wheel. The objection may be raised that needle-shaped particles in grinding wheels may be oriented somewhat tangentially in the face of the wheel, thus giving the effect of a relatively larger particle

* Issued by the National Academy of Sciences, Washington, DC, in August, 1957.

and causing scratches on the surface of the article being ground. We have not found this to be so; Table VI illustrates this point. The tests for

TABLE VI

The effect of particle shape on grinding finish

Grit type	Average surface finish (microinches)
Normal 120 grit	12-15
120 grit, needles and flats	11-16
Normal fine grit 200-240	6-12
Fine grit, needles and flats 200-240	7-13

Table VI were conducted at 0.001 in. downfeed, 0.050 in. crossfeed, and the wheel speed was 5,500 surface ft/minute. The readings were taken at every twenty-fifth pass of the wheel across the workpiece in a total of 100 passes for each wheel.

In order to give the best results, grit for resin-bonded wheels should have a rough or irregular surface, and it should also be in a condition where the particles will break down in small fragments under impact. For the lack of a better description we can refer to this as a friable condition. The Diamond Research Laboratory has produced a natural grit which has all these requirements; the methods of production are controllable so that the amount of friability induced will not make the particles too fragile.

Table VII shows the grinding results that can be achieved with these special grits which have been developed in the Laboratory, compared with results from normal material generally employed. The grit sizes used in the special wheels were: coarse—80/115 Tyler, medium—115/200 Tyler, and fine—200/400 Tyler; the normal wheels contained ordinary grit in the sizes stipulated by Norton Abrasives in the coarse, medium, and fine ranges, *ie* '100S', '120', and '240'.

Blocky particles

The blocky particles of grit which, as far as possible, should be avoided in resin wheels, since they break too easily out of the wheel, find their best application in metal-bonded wheels and in saws. Operating pressures with metal-bonded wheels and saws, owing to the tough nature of the bond, are, in general, much higher than in resin-bonded wheels, and since blocky particles of natural diamond can be firmly held in metal bonds, full use can be made of their strength and resistance to abrasion.

Fig 14. The grinding face of a metal-bonded grinding wheel, showing how the blocky natural diamond particles protrude from the bond and protect it.

Fig 15. The grinding face of a metal-bonded wheel showing how the friable synthetic diamond has broken down level with the surface of the bond. The wheel will not cut in this condition.

TABLE VII

Effect of particle shape and condition on grinding results

Grit size	Particle shape	Efficiency ratio (average 12 results)	Efficiency ratio expressed as percentage	Downfeed (inch)	Wheel feed (surface ft/min)
A Coarse	Normal	27	100	.001	5,500
	Special grit (80/115 Tyler)	39	144	.001	5,500
B Medium	Normal	23	100	.001	5,500
	Special grit (115/200 Tyler)	38	136	.001	5,500
C Fine	Normal	31	100	.0005	5,500
	Special grit (200/400 Tyler)	44	142	.0005	5,500

Although not entirely within the scope of this paper, we include two figures which show the comparison of metal-bonded wheels set with blocky natural grit and synthetic material Figs 14 and 15 are photographs of the face of

metal-bonded wheels containing natural and synthetic grit respectively. It should be noted in Fig 14 that the blocky natural diamond particles protrude from the face of the wheel and prevent the metal bond wearing away. The synthetic grit in Fig 15, on the other hand, has broken down and has not protected the metal bond which is worn smooth. The wheel cannot grind in this condition.

Conclusion

From the foregoing, it is clearly indicated that the natural grit generally used in resin-bonded grinding wheels can be improved by selection of particle shape and condition. To achieve the best result, grit intended for resin-bonded wheels should have the blocky particles removed and should have an irregular or rough surface to be more satisfactorily held by resin. The particles should fragment relatively easily so that the bulk of the particle will remain embedded in the resin. The efficiency of wheels employing this type of grit will be up to 40% higher than with wheels containing the conventional type of natural grit.

Acknowledgement

The author wishes to acknowledge with sincere thanks the very able assistance and the many valuable suggestions offered by Dr J. F. H. Custers, Co-Director of the Laboratory, and also the following members of the staff of the Diamond Research Laboratory:

Dr H. B. Dyer
Mr C. J. Guykers
Mr C. M. Levitt
Dr F. A. Raal
Dr A. R. Roy
Dr W. B. Senior

We would like to place on record our sincere appreciation of the assistance and co-operation we have had from Nortons: in many cases our test wheels have taken precedence over their own production. We also know that during manufacture our wheels have had the closest supervision to ensure that they conform in every way to the company's very superior standard of production.

Conclusion

Aid for Surface Finish Testing

The plastic compound kit shown here contains all necessary equipment for reproducing surfaces inaccessible to surface finish testers. The items in the kit are a bottle of liquid for cleaning the surface to be tested, a bottle of liquid for mixing the compound, a bottle of powder, a mixing bowl, a measure, and plasticine. The surface to be tested is first cleaned with the liquid provided, and a plasticine 'wall' is built round the required area. A mixture of the compound is poured in; this sets in 10 minutes, producing the shape of the surface.

The testing kit comes in this handy box, ready for use.

New Theory on Formation of Diamond

Professor Ashot Aslanyan, Armenian geologist, has put forward the hypothesis that diamonds are formed from carbon which is separated in the explosion and disintegration of magmatic acetylene at high pressure and high temperature. This hypothesis is contained in his latest work, 'Some Problems of the Theory of Volcanic Activity,' which sums up many years of research into the formation of the Earth's crust and volcanism.

In it he makes a thorough examination of the origin of the energy of a volcanic eruption, which he associates with subterranean electrical discharged and gas (hydrocarbon) reactions. A tremendous heat is released and pressures of between 100,000 and 200,000 atmospheres or more are developed.

Professor Aslanyan believes that the eruption results in the crushing of the rocks in the diamond-bearing kimberlite pipes.

No Room at the Top

W. J. Edens, agricultural attache at the US Embassy in Pretoria, says that agriculturally, industrially, and culturally, South Africa has become Africa's most important country and is 'right at the top' in the production of diamonds.

Israel Diamond Trade Expanding

Mr P. Sapir, Israel's Minister of Commerce and Industry, has said that the Ministry hopes to open a number of diamond polishing workshops in Beersheba, Eilat, Ashdod, and Jerusalem within the next few months.

He disclosed that diamond exports this year may reach $40 million, compared to $33 million last year and some $20 million in 1957.

Microwave Controlled Grinding of Ceramic Radomes

by Nestor Grechny, jun*

This article has been simplified from the text of a paper presented by Mr Grechny recently in the United States. Further details are available to any of our readers who may be interested in the practical development of the process here described. It is, of course, readily adaptable to other types of workpieces and to other materials, and is particularly suitable to any grinding process in which the conditions either of material or of tolerance are especially severe.

Introduction

The need for nose-cones capable of high temperature operation has evoked a great effort from the ceramics industry to produce a satisfactory ceramic radome. Problems associated with radome manufacture are, in general, greater than problems encountered in that of most other ceramic items. Structural and electrical requirements of the radome are stringent; large parts with great strength are demanded and close tolerances are specified by the electrical aspects.

Assuming that the radome is satisfactory structurally, the problem of close-tolerance wall sizing must be met. Normally, the ogival part is formed on a male mandrel, removed, and fired. Shrinkage and a small amount of deformation occurring during the firing stage necessitate an inside and outside grind to yield the critical dimension, the radome wall thickness. The jigging, the two surface grind, and tolerance control are difficult as well as time consuming and costly. A simpler and faster method of radome wall grinding is needed.

A new method of ceramic radome wall sizing is now available, which is based on microwave control and requires grinding of one surface only. Furthermore, the technique results in tolerances which are independent of part size. The basic procedure requires that the radome be formed slightly thicker than required. After firing, the radome is inspected with a microwave interferometer which reads the electrical thickness and infers the physical thickness of the part. A grind is programmed to remove the excess wall thickness from the outside surface. A surface reference in the form of a transducer is located immediately adjacent to the grinding wheel, and, since the grind is based on removal of a known amount of material from the surface, the grind becomes independent of part size. The grind is monitored with the interferometer and, if required, minor adjustment can be made to the programmed grind. After sizing, a final acceptance check is performed with the controller.

The one horn interferometer controller

A one horn interferometer is used as the controller for the grind. The device is an extension of normal two horn interferometry techniques but is more compact and versatile than a two horn interferometer. This instrument has proved its controlling qualities in the sizing of plastic radomes, although used in a different manner.[1] Energy from a stable microwave signal generator is split into reference and test arms of the interferometer. A single horn, located in the test arm, is used to transmit and receive a signal which is incident normal to a dielectric panel (in this case the radome wall) from which it is then reflected. The reflected energy is coupled into a ' magic tee ' and is vectorially added in each side arm of the tee to the reference arm signal. Recalling the characteristics of the ' magic tee ', under a matched load condition, signals fed into the sum and difference arms will result in equal outputs in the side arms when the two signals are in quadrature at the tee. The detection scheme, therefore, is amplitude independent and is such that a null is obtained when reference and test arm signals are in quadrature. A simple DC bridging system is utilized, and the output is displayed visually as well as being recorded.

Measuring thickness with the interferometer

Measurement of physical thickness is not made directly with the interferometer. Instead, the electrical thickness is first measured and then, knowing the material characteristics, the physical thickness is calculated. The extreme uniformity

* Applied Physics Staff, Pilotless Aircraft Div, Boeing Airplane Company.

of the dielectric constant of ceramics ensures a constant relationship between the physical thickness and electrical thickness of the radome wall. The measured quantity, the phase retardation of a plane wave normally incident upon and then reflected by the radome wall backed with either dielectric material or an electrical conductor, is readily calculated. However, owing to interaction between the electro-magnetic horn and the radome wall, the calculated phase value cannot be realized without undertaking a long series of measurements. Regardless of the errors introduced in reading, a given phase condition is easily established and is repeatable. This repeatability permits the determining of accurate wall thickness values.

The phasing error problem, which is the direct result of horn aperture reradiation, is solved by using the instrument as a comparator rather than as an absolute gauge. As such, it is a referencing system capable of measuring small wall thickness variations centred about a target value. To establish the interferometer as a reference system, a set of primary standards must be manufactured. Each standard is made from an appropriate sample of the dielectric material used in the radome manufacture, and its thickness is measured with a micrometer. Each sample must be uniform and the faces parallel. It must further be prepared so as to duplicate the condition of reading of the radome wall; that is, the standard must be backed with air, water, or an electrical conductor such as a metallic spray. Phase is then measured with the one horn interferometer by placing the sample normal to the axis of the propagation and at a fixed distance from the horn. The electrical phase read on the phase shifter is thus associated with the known physical thickness of the sample. Through use of several such samples or standards, a relationship is established between physical thickness and the phase readings.

To facilitate recording and ease of reading, the detection system is calibrated to read physical thickness directly. This is accomplished by series-bucking the output from each detector in the tee through a centre reading galvanometer. A parallel output is provided for recording purposes. Through adjustment of the phase shifter, signals in the reference and test arms of the interferometer are set in quadrature at the target phase value as determined from the standards. Thus, the galvanometer is nulled at the target thickness. By introducing the correct phase shifter and with proper shunting of the galvanometer, the galvanometer scale is calibrated to read directly a limited range of physical thickness variations about the target value. Phase variations as indicated are readily detected by the interferometer with minimum detectable variation in the order of 0.2°. Sensitivity of this magnitude is greater than necessary for production control.

It is of utmost importance that the spacing between the electromagnetic horn and the radome wall be maintained constant. Difficulties may arise in maintaining angular and dimensional accuracy for some radome shapes. In general, the problem is solved by using a rigidly mounted rotating microwave joint immediately preceding the horn. Wide set out-riggers which ride the radome surface are attached to the horn and space the horn from the radome. Two thousandths of an inch is a desirable spacing. The interferometer is mounted so that the out-riggers ride the radome surface under the force of gravity. The tracking drive is set in the plane of the longitudinal axis of the radome with the long dimension of the horn set parallel to the radome axis, thereby minimizing curvature errors.

The curved form of the part introduces errors in interferometer readings for small radii. To determine these errors, parts of various radii of curvature must be measured with both the interferometer and a micrometer. Deviations in readings are thereafter used as a correction to interferometer readings.

Increasing measurement sensitivity and accuracy

It is apparent from examination of the phasing derivations in this particular usage that the best accuracy and thickness sensitivity is realized when the maximum interface reflexion is obtained from the panel interface farthest from the electromagnetic horn. The magnitude of the reflexion at the interface between medium *a* and medium *b* is given by

$$R = \frac{n_b - n_a}{n_b + n_a}$$

where n is the refractive index. In general, the medium on either side of the radome wall will be air. However, if it is desirable to increase sensitivity, the radome may be inverted and filled with water. Assuming an interferometer frequency of 10^{10}mc, a plot is made of the reflexion coefficient as a function of the dielectric constant of the radome wall for the cases of air and water filled radomes. For values of dielectric constant above 7.350, an air backing is more desirable. An even more desirable backing is an electrical conductor which results in total reflexion at the interface. Spraying the interior surface of the radome with a metalized paint or pigment which can later be

removed with a solvent will produce this most desirable condition.

Although an air rather than a water backing is preferable for higher values of dielectric constant, the accuracy of readings may be improved through use of water. Inaccuracies result from the energy which is transmitted through the radome wall, reflected by the far wall of the radome, again transmitted through the radome wall nearest the horn, and received by the horn. No such reflexion is obtained when the radome interior is coated with an electrical conductor. If the radome is air filled, it is necessary to line the interior with microwave absorbing material, thereby attenuating the undesirable reflexion. An alternative is the use of water, which is highly attenuating at microwave frequencies.

Procedures for wall sizing

Upon completion of the firing cycle, the radome has undergone a limited amount of distortion and shrinkage. Normally, the deformation is not large enough to exceed runout or waviness tolerances, but is more than enough to necessitate inside and outside grinding or special grinding techniques to yield the specified wall thickness. The part is, of course, thicker than the required value after firing. At this point, it is inspected with the interferometer and thickness is mapped over the entire radome area using the techniques discussed in the preceding paragraphs. It should be noted that the surface of the radome is the only reference required to measure its thickness, and subsequently to perform the grinding operation. From the thickness records obtained, a grind is programmed to remove a small prescribed amount of material from the surface of the radome.

The instrumentation for the grind consists of a transducer located immediately adjacent to the diamond grinding wheel. The entire unit is mounted on a track along the longitudinal axis of the radome. Track tolerance requirements are extremely loose and are a function of the range of linear operation of the transducer. If, for example, the linear range is 1/2 in., tolerances of about $\pm$ 0.20 in. are acceptable. The only requirements placed on the track are that it does not move the transducer beyond its operating range and that it directs the grinding wheel unit along the longitudinal axis of the radome.

In operation, the output from the surface reference transducer drives the servo motor which then drives the grinding wheel in the depth dimension. The wheel is stopped at the correct depth when the output from the transducer reaches a null condition. The depth of grind is determined with the bite control which merely introduces a bias voltage on the transducer output. Monitoring of the manually controlled grind can be undertaken with the one horn interferometer and minor corrections may be incorporated into the programmed grind if required.

Complete automation can be realized by using the interferometer output as the grinding wheel bite bias. In this condition, a data storage unit must be introduced to account for the time delay between the reading and grinding at a point. The time delay can, for example, be introduced with a tape of constant time lag if the part is ground in a spiral at constant angular velocity. Programming of the grind can thus be eliminated. However, a preliminary inspection of the part would still be advisable.

Effects of radome basic design parameters

The fundamental qualities of a radome are expressed by the radome boresight errors or boresight error rates, transmission, and reflexions by the radome into the seeker. These qualities are minimized, maximized, or optimized by the radome designer through specification of the radome wall dimension. The wall dimension is specified by either physical thickness, or some form of electrical thickness. The preceding techniques description is based on a physical thickness specification.

More recent design techniques[2] assume the radome Insertion Phase Difference IPD as the basic radome design parameter. Using the IPD as the basic radome design parameter does not in any way invalidate the radome sizing method presented here. Since the IPD is the phasing difference presented by the radome wall to an impinging electromagnetic wave, standards are established to correlate one horn interferometer phasing with the IPD of the standard. The IPD is measured using standard two horn interferometry techniques utilizing parallel polarization and measuring at Brewster's Angle.

Limitations of usage

The one horn interferometer as such is not capable of accurate absolute interferometry. It must be utilized as a comparator and the standards must be representative of the radome wall material. The sample dielectric constant should not deviate materially from that of the wall material.

Angular and dimensional accuracy between horn and part must be maintained, although one

or two degrees and one or two thousandths spacing error are often permissible.

Conclusions

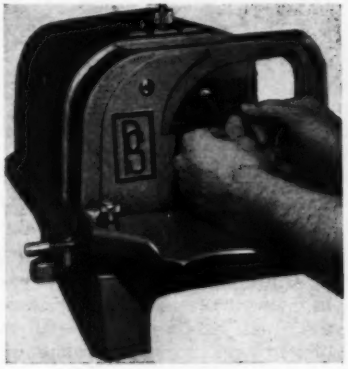
The extreme dielectric uniformity of ceramics permits adaptation of a grinding technique which can produce a physical thickness of given tolerance regardless of the size of the part. It is apparent that use of the method can be extended to parts other than radomes. Little can be gained using this idea in sizing small items since standard grinding techniques can be applied readily and simply. The greatest field of application appears to be in radomes, where the product is normally large and sizing is critical.

[1] Frank S. Holman, Melvyn R. Paisley, and Nestor Grechny, jun. *Proceedings of the WADC-OSU Radome Symposium* 1958 Vol 3 (Secret), Controlled radome uniformity through one horn image plane interferometry.

[2] Frank S. Holman and Melvyn Paisley, Radome design through correlation of radome optimum frequency and insertion phase difference *Proceedings of the OSU-WADC Radome Symposium* 1957 Vol 1 (June).

Motorized Diamond Hand Edger

The new machine, by Pad Specs Ltd, uses a 5 in. diameter diamond cup wheel with 1/8 in. 180 mesh diamond thickness. The wheel employs a light press-on fit, and can be dressed, using a coolant, with a C180/N/VGN Carborundum stick. The standard motor is the 220/240 v single-phase type.



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Forthcoming Exhibitions

Two exhibitions, one taking place in the Autumn of this year and the other in the Spring of 1960 are likely to be of special interest to the readers of the Industrial Diamond Review.

The Italian Jewelry Exhibition to be held in the Commercial Art Gallery in Milan in November will contain a section specially devoted to diamonds sponsored by De Beers.

This will incorporate a part relating to Industrial Diamonds and will include several working models demonstrating one or two of the uses of industrial diamonds. These models are to be in the nature of three-dimensional diagrams rather than strictly accurate models and will be intended to attract the interest of the visitors more than give an actual demonstration of the tools in use.

By contrast, the second exhibition, to be held in Birmingham in February and March 1960, will include in the Industrial Diamond exhibit (which will be shown in the Birmingham Science Museum) an extensive range of machine tools in actual working conditions. Here again, the exhibition of industrial diamonds will be held in parallel with a show of gem diamonds (in the Birmingham Art Gallery) and once again both parts of this exhibition will be sponsored by De Beers.

It is proposed to have a static exhibition of industrial diamonds in the rough in a partly prepared state and as finished tools in all cases accompanied by suitable photographs, which will help to explain to the general public and in addition in a separate gallery of the museum machine tools in action already referred to. The cooperation of the machine tool and tool making industries is expected to make this a really useful and impressive demonstration of the extent of the uses to which industrial diamonds are put throughout the engineering industries.

Helpful Selection Chart Available

Adamas Carbide Corporation offers a complimentary guide to proper carbide grade selection and application. It features an up-to-date grade chart listing industry designations C-1 to C-14, cross-referenced with the designations of 15 producers of tungsten carbide. In addition, there are constructive tips on application and procedure, as well as suggestions on how to counter effects of edge wear, cratering, chipping, and breakage.

The data is printed in two colours on both sides of heavy ply soil resistant stock, and is supplied ready punched for wall mounting or insertion in a three-ring binder. For a free copy, write to Adamas Carbide Corporation, Kenilworth, NJ.

Drilling for a bomb

We have often brought to the notice of readers certain examples of unusual tasks performed with diamond drills. It is only fair, we feel, that when a non-diamond drill accomplishes something equally unusual then this should also be recorded. The drilling set-up shown above is using Reed roller bits to probe for an unexploded bomb at the rear of the Tate Gallery. The bomb is believed to be a 500 pounder.

Dr Schneider's British Rep

British agents for the Schneider optical screw cutting, tool setting, and profile gauge (*IDR*, April) are: Nonius Ltd, 38 Beethoven Street, London W 10.

Concluded from p 145

investigations into the action of a grinding wheel, and of nearly all the other familiar tools are being pursued. The consequence of such experiments should be a greater economy in the use of material, and a greater satisfaction with the results of its use.

ADAMANT

New US Tool Sharpening Machine

Five angles + tip radius

Although designed principally for use with Heald Bore-Matics to provide low-cost grinding of boring tools, the Heald Model 3 tool sharpener, Fig 1, can also be used for single-point carbide-tipped tools used on other machines. Set-up and operation are simple, and direct-reading scales allow up to 5 different angles, plus the tip radius, to be ground at one setting. Wheel speed is 5,000 rev/minute.

Freehand grinding

The design allows for the addition of an extra wheel and freehand grinding attachment on the left-hand side of the machine. This can be used for sharpening odd-shaped tools or for roughing shapes which will be precision-ground on the right-hand side of the machine.

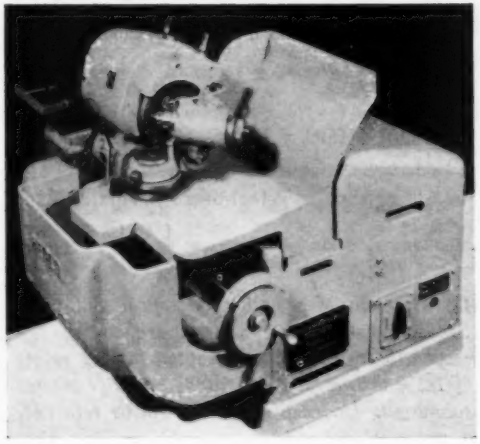


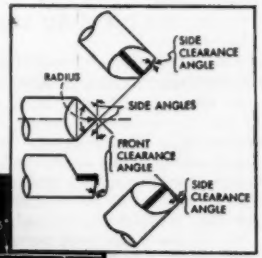
Fig 1. The Heald Model 3 tool sharpening machine.

Capacities

Additional data:

Front clearance angle	— 10 to 30°
Radius adjustment (depending on length of tool)	0 to 1¾ in.
Off-centre adjustment (each side) ...	5/16 in.
Swing of tool holder:	
using front face of wheel	55° to rear, 93° to front
using rear face of wheel	75° to rear, 57° to front

Fig 2 (right). All five angles and the radius can be ground in one set-up. On an optical comparator, these angles and the radius will check exactly with the template, as will those of all subsequent tools sharpened at the same settings.



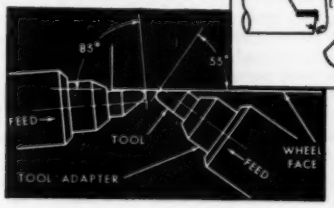


Fig 3 (left). Methods of applying tool to wheel and angles available.

Change of Address—Stedall & Co Move

Stedall & Co Ltd, formerly of High Holborn, have now moved to 192-204 Pentonville Rd., London N 1. The new premises will house the whole of the stocks of Stedall & Co Ltd; Farmer, Stedall & Co Ltd; and Hunts Motor Factors, with the exception of the Metal Division which is at St John's Wharf, 29 Carnwath Rd, Fulham, London SW 6.

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INDUSTRIAL DIAMOND ABSTRACTS

Industrial Diamond Information Bureau,
2 Charterhouse Street, London, EC 1.
Telephone : FLEet Street 1577

1959 Volume 16
AUGUST

DIAMOND MINING AND INDUSTRY

Diamonds. Developments in South Africa. Diamanti. Gli sviluppi nel Sud Africa

Anon. *Industria Mineraria* 1959 Vol 10 (5) p 309 (May) (In Italian)

Short history of De Beers Consolidated Mines Ltd and Diamond Trading Ltd. A table shows the diamond production in 1938, and 1947 to 1954, indicating a steady rise until 1952, after which the production figures levelled off. 1 table.

M *F.13.361/F.28.361*

British Guiana

Anon. *Gems & Gemology* 1959 Vol 9 (9) p 284 (Spring)

14,344.75 metric ct of diamond was mined in British Guiana during the first six months of 1958, an increase of 290.28 metric ct over the same period in 1957.

W *F Hd.3474*

Alluvial diamond digging in Basutoland. Diamantschuerfung in Basutoland

Anon. *Dtsch Goldschmiede Ztg* 1959 Vol 57 (6) p 329 (June) (In German)

A Johannesburg mining and financial company has recently undertaken explorations on the rivers Kau and Malibiamatso, after long transactions with the governing bodies of the Protectorate of Basutoland. Odd stones have been found in the region previously, although systematic searches have not been carried out. The Government will have a share of 10% of all diamonds found there.

A *Ebeb He.361*

Diamonds of Yakutia

N. Cherskii. *Sib Ogni* 1959 Vol 38 (1) pp 122-125 (Jan); *Library of Congress Mthly Index Russ Access* 1959 Vol 12 (2) p 611 (May) (Original in Russian)

W *Eb.332*

France announces relaxation of import restrictions on pearls and gemstones. Frankreich verfuegt Importerleichterungen fuer Perlen und Edelsteine

Anon. *Dtsch Goldschmiede Ztg* 1959 Vol 57 (6) p 329 (June) (In German)

The Chambre Syndicale des Négociants en Diamant, Perles, Pierres précieuses et des Lapidaires in Paris has announced that the import restrictions on pearls, diamonds, and other precious stones are being relaxed. Real pearls, rough diamonds of all kinds, cut and uncut sapphire, rubies, and emeralds may be imported free. Cut diamonds may be imported from OEEC states.

A *Bb.251/F.251*

In the diamond territory

G. Lezgincev. *Ogonek* 1958 Vol 36 (47) p 7 (Nov); *Library of Congress Mthly Index Russ Access* 1959 Vol 12 (2) p 611 (May) (Original in Russian)

W *Eb.332*

Situation of the Belgian industrial diamond trade

J. Wegloop. *Diamant* 1959 Vol 2 (12) pp 18-20 (May) (In English, Flemish, and French)

Comments on relations between the DTC and the Belgian industrial diamond trade.

W *Fc.251.3235*

Market reports

S. Emmerik *et al.* *Diamant* 1959 Vol 2 (12) pp 27-32 (May) (In English, Flemish, and French)

Reviews of the following industrial diamond markets : Antwerp, New York, Tel Aviv, Amsterdam, Paris, London, and Rome. *W* *Fc.251*

Diamond hunters

B. Babliuk. *Sib Ogni* 1959 Vol 38 (1) pp 126-131 (Jan); *Library of Congress Mthly Index Russ Access* 1959 Vol 12 (2) p 611 (May) (Original in Russian)

W *F.12.332*

We regret that, owing to the delayed effects of the printing dispute, this issue of Industrial Diamond Abstracts is somewhat shorter than usual. We hope to return to normal size next month.

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Diamond Mining and Industry	A145	Wire Drawing	A150
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PHYSICAL, CHEMICAL, & MECHANICAL PROPERTIES OF DIAMOND AND OTHER HARD MATERIALS

M stands for man-made

R. L. McKee. *Carbide Engg* 1959 Vol 11 (6) pp 24-26 (June)

J. Kennedy and J. T. Elovich, both of Gen Electr Co, answer the following questions on synthetic diamonds: (*i*) why do synthetic diamonds act differently from natural diamonds? (*ii*) does improved performance follow automatically on changing from natural to synthetic grinding with resinoid- or vitrified-bonded grinding wheels, or must grinding procedures also be changed? (*iii*) clarify the statement that '75 concentration MD [synthetic] wheels can do the same job as 100 concentration D [natural] wheels; (iv) what synthetic grit sizes are available, and will this range be extended? (*v*) why are synthetic diamonds unsuitable for electrolytic grinding? (*vi*) does the Gen Electr Co envisage sintered diamond cutting tools made from synthetic diamonds? and (*vii*) what is the biggest problem in the manufacture of synthetic diamonds? 1 illustr.

W *Fc*Fh*

Ruby—from aluminium. Il rubino—dall'alluminio

Sovinformbureau. *Metallurgia Italiana* 1959 Vol 51 (2) p 46 (Feb) (In Italian)

At one of the laboratories of the Institute of Crystallography, the Academy of Sciences of the USSR dealing with the manufacture of synthetic superhard monocrystals, a process has been invented for the manufacture of synthetic ruby which is claimed to be inferior in hardness only to diamonds and some carbides. *M* *Bbeb Qc.33*

The light and purity of diamond and the beauty of emerald

Anon. *Goldsmiths Journ* 1959 Vol 65 (485) pp 312, 314 (July)

A brief discussion covering sources of diamonds, historic diamonds, and superstitions relating to diamond. The emerald is similarly treated. 1 illustr.

W *Bbjb.28/Eb/F.28*

Highlights at the Gem Trade Lab in New York

G. R. Crowningshield. *Gems & Gemology* 1959 Vol 9 (9) pp 268-270, 286 (Spring)

Red diamonds, showing the colour of pyrope garnet in reflected light, showed the 5920 AU band in spectroscopic analysis—a band characteristic of yellow treated diamonds. Several new hues, artificially induced, are available. Yellow treated diamonds are becoming increasingly common. An orange-brown diamond showed no evidence of treatment. 1 illustr.

W *F Ukb*

The origin of healing fissures in gemstones. Die Entstehung der Heilungsrisse in Edelsteinen

W. F. Eppler. *Journ of Gemmology* 1959 Vol 7 (2) pp 40-66 (Apr); *Dtsch Goldschmiede Ztg* 1959 Vol 57 (6) pp 321-324 (June) (In German, original in English)

(To be cont). 10 illustr, 1 table.

W *Bb Uz*

Identifying gemstones. V. Wir bestimmen Edelsteine V

Anon. *Gold & Silber* etc 1959 Vol 12 (6) pp 32-34 (June) (In German)

The crystal formation of the more common gemstones, including diamond, is described. Diamond is shown as an example of the regular cubic form. 7 illustr. *W* *Bb Cz/F Hk*

Crystal orientation by means of a differential Laue pattern

Z. Cuchy. *Jemna Mechanika a Optika* 1959 (6) pp 202-203 (In Czech, abstr in English)

A method which permits the orientation of crystals with a precision of 2′, and particularly suitable for the correction of the crystal axial sections. The principle of the method as well as the working procedure are described, and the Laue pattern evaluation is shown. 2 illustr, 3 ref, 2 tables. *X* *Bd Ubc*

Formations of minerals, physical properties

R. Jahns. *Gems & Gemology* 1959 Vol 9 (9) pp 271-279 (Spring)

(Cont). Subjects covered are zoning and inclusions, twinning, cleaving, parting, fracture, and hardness. The hardness of a mineral is defined, and a table shows the Mohs, Jaggar, Vickers, and Knoop hardnesses of ten common minerals ranging from diamond to talc. (To be cont). 1 illustr, 1 table.

W *Bc U/Bc Unh.513/F Unh.513*

The anelasticity of natural and synthetic quartz at low temperatures

J. C. King. *Bell System Techn Journ* 1959 Vol 38 (2) pp 573-602 (Mar)

18 illustr, 1 table, 23 ref. *A* *Bc Ukb*

Coloration of minerals. Die Faerbung der Minerale

K. Pschibram. *Sowjet Buchneuerscheinungen Vorankuendigungsdienst* 1959 (17) p 9 (Original in Russian)

Book, translation from the German and English, 288 pp, Isd-wo II. Price: DM 7.30.

A *Bc Ukb*

DIAMOND, ETC, IN INSTRUMENTS

Behaviour of solids under extremely high pressures

US Nat Bur Standards. *Machinery* (London) 1959 Vol 94 (2432) p 1372 (June 24)

Recent research has indicated that changes occur in the molecular structures of solids subjected to pressures of the order of 30,000 atmospheres. Determination of these changes was made possible by the use of two diamonds ground so that their flat surfaces were parallel to a beam of light. The specimen to be studied was placed between the flat surfaces and subjected to extremely high pressures. The material was thus reduced to a thin film, and the light passing through the diamonds and specimen could be analysed with a spectrometer. Each diamond is mounted at one end of a cylindrical steel holder, and the holders are mounted in a rig with the flat faces of the diamonds facing each other. A screw and lever system applies the pressure which, with a thrust of 70 lb, is 400,000 lb/sq in. at the 0.00015 sq in. faces of the diamonds. Only 1% of diamonds is suitable for use in the instrument, as the remaining 99% possess unsuitable absorption bands. Those used have an absorption band near the five micron wavelength, apart from which they are transparent to light of wavelengths of from 0 to 35 microns. *W* *B Cz Unq:Nd*

Swiss P 334,721 (Apr 13, 1956) **A. Peter, Gebr Peter Hole finishing machine for watch jewels.** Grandiermachine fuer Uhrensteine

In known machines the finishing wires are mounted on a carriage which is reciprocated in relation to the

stationary jewel holders. This arrangement requires much unnecessary space and material. In the new machine each finishing wire passes over guide rolls and is alternately pulled downwards to the one or the other side. (6 claims, 7 illustr).
J *Bb Cfdb Tc.545*

Swiss P 334,723 (Apr 13, 1956) **A. Peter, Gebr Peter Hole finishing machine for watch jewels.** Grandiermaschine fuer Uhrensteine

The usual machine is a special kind of lathe whose spindle is a rail accommodating a series of watch jewels. The finishing wire is threaded through the jewels in the axis of the spindle. The wire is moved longitudinally in relation to the spindle which is simultaneously rotated. The finishing wire is corrugated and these corrugations are filled with a paste, *eg* diamond dust in oil, applied against the inside walls of the drilled jewels by these corrugations. They are produced by a device consisting of two loosely meshing and adjustable gear wheels. The corrugations have to be enlarged during the operation as the size of the holes in the jewels increases, and the production of the new corrugations requires much time and skill. This work is not necessary in the new machine in which the tension of the finishing wire is so controlled that if the friction of the corrugations inside the jewels decreases owing to the increase in diameter of the holes, the tension is somewhat lessened so that the corrugations of the wire become larger through the elasticity of the wire and thus again correspond to the larger holes. (6 claims, 7 illustr). *J* *Bb Cfdb Tc.545*

HARDNESS AND WEAR TESTING

Grinding wheel tests on cemented [sintered] carbides reveal hardness variations

R. G. Weavind (Diamond Res Lab, Johannesburg). *Carbide Engg* 1959 Vol 11 (6) pp 30-31, 33 (June)

A report of a talk to the Industrial Diamond Assoc of America.

Grinding tests on sintered carbide, using diamond grinding wheels, indicated that the 'skin' of carbide specimens ground away more quickly than the centre of the specimen. To ascertain the variation in hardness, a piece of carbide was sawed in half perpendicular to the workface. The sawed face was polished, and a series of Bergsman microhardness tests was made across the polished surface. Tests performed on South African and American carbides showed a fairly hard outside, softening towards the centre, becoming harder at the centre, softening again after the centre, and hardening again as the other side of the specimen was reached.

Grinding tests resulted in a similar wear pattern. The superiority of SND-Resinoid diamond grit over conventional diamond grit was proved, using tests which reduce the effects of the hardness variations. 6 illustr, 1 table.
W *Bkc Cv:Nv/Bkc Cw:Nv*

Methods of testing and machines for testing on synthetic resins. Pruefverfahren und Pruefmaschinen fuer Plaste

K. Melzer. *Feingeraetetechnik* 1959 Vol 8 (6) pp 247-251 (June) (In German)

Included in the series of testing processes is that of hardness testing. The method usually accepted for testing synthetic resins is the Brinell test. 13 illustr.
A *Bp Cv Wgh*

Study of resistance of steel to wear of Kapron [Nylon] thread

P. T. Basko. *Metallovedenie i Obrabotka Metallov* 1958 (12) pp 56-57 (Dec) (Original in Russian)

[Transl av, H. Brutcher, PO Box 157, Altadena, Calif. Price : $5.75, No 4392].
W *Bfd Unr.21*

Study of white layers under conditions of wear entailing destructive pitting

F. Ya. Iokheles. *Metallovedenie i Obrabotka Metallov* 1958 (10) pp 28-33 (Oct) (Original in Russian)

[Transl av, H. Brutcher, PO Box 157, Altadena, Calif. Price : $5.75, No 4392].
W *Bf Unr.21*

Influence of stresses on wear of carbides

L. G. Kuklin. *Machines & Tooling* 1959 Vol 30 (3) p 31 (Original in Russian)

The results of investigations described show that the wear of carbides is increased by a factor of 1.5 to 2 if the carbides have considerable residual stresses. This is one reason for the short life of some carbide tipped tools. 2 illustr. *W* *Pdc Uqe:Unr*

Tool wear and machinability

S. Kumar. *Inst Prod Engs Journ* 1959 Vol 38 (6) pp 342-343 (June)

Comments on article of the same title by E. M. Trent [see *Ind Diamond Abstr* 1959 Vol 16 p A60 (Apr)]. Dr E. M. Trent replies. 1 illustr.
W *Pdc Unr*

Wear of cutting tools

T. N. Loladze. *Library of Congress Mthly Index Russ Access* 1959 Vol 12 (2) p 534 (May) (Original in Russian)

Book, Gos nauchno tekhn izd-vo mashinostroit litry, Moscow. 1958, 355 pp. [Not in library of Ind Diamond Inf Bur]. *W* *Pd Unr*

Effect of electroplating conditions on structure and wear resistance of iron deposits

Yu. N. Petrov. *Metallovedenie i Obrabotka Metallov* 1958 (12) pp 53-56 (Dec) (Original in Russian)

[Transl av, H. Brutcher, PO Box 157, Altadena, Calif. Price : $3.25, No 4450].
W *Bfc Chpb*

Evaluation of high temperature properties from rupture and hot hardness tests

Yu. A. Preobrazhenskaya. *Zavodskaya Lab* 1957 Vol 23 (4) pp 485-487 (Original in Russian)

A study of the effect of grain structure and state of grain boundaries in hot hardness tests on various aluminium alloys to obtain information on whether relatively short hot hardness tests may take the place of long-time rupture tests in the development of new high-temperature alloys. [Transl av, H. Brutcher, PO Box 157, Altadena, Calif. Price : $3.75, No 4594].
W *Bfxc Ubb.21:Cvz*

Investigation of the hardening of sodium silicate-bonded sand

C. E. Wulff. *Trans Am Foundrymen's Soc* 1958 Vol 66 pp 91-95 ; *BSCRA Abstr* 1959 Vol 8 (3) p 9 (May)
W *B Unh*

LITERATURE REQUESTS
Please quote the page number of the journal which contains the original reference, and the author and title of the article, in all cases.

USP 2,865,198 **L.Tschirf, F. Gaertner**
(July 9, 1953—conv date, Austria)

Hardness testing apparatus

The tester is designed for testing surfaces difficult to reach (inside surfaces, tubular bodies, inside cones, internal threads, parallel plane internal surfaces, teeth, et cetera). For this purpose the tester head is chucked to the surface to be tested in a position normal to the surface, with a chucking force independent of and stronger than the indenting force. As shown in Fig 1 and 2 the testing head 9 is clamped inside the tubular specimen 6 between points 25, 26, and the edges of two-armed lever 19, while indenter 5 on leaf springs 13, 14, is independently loaded through plunger 1 and transmitting member 3. (10 claims, 5 illustr). Ref cited : 3 USP ; 2 GP ; 2 DBP ; 1 Italian P ; see also GP 623,171 ; FP 55,639 ; USP 1,048,073.

J *Wgh.545*

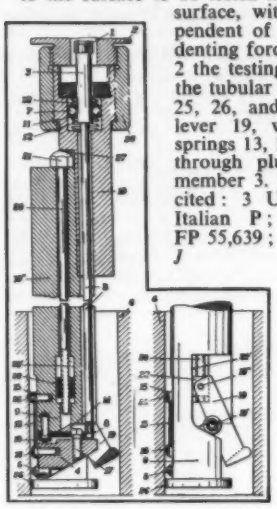

Fig 1 (far left) and 2. Details of new hardness tester for testing hard-to-reach surfaces. USP 2,865,198.

TRUING OF GRINDING WHEELS

Clamp diamond holder aids quick wheel truing

H. J. Gerber. *Grinding & Finishing* 1959 Vol 5 (2) p 46 (June)

A clamp-on truing diamond holder is shown. It features a v-seat for clamping on cylindrical surfaces, and can be clamped directly on the work or on a scrap shaft held between centres. 1 illustr.

W *Cg Nj:Mf*

Semi-automatic grooved hub grinding machine.
Halbautomatische Keilnabenschleifmaschine

A. Saurer AG, Arbon, Switzerland. *Technica* 1959 Vol 8 (13) p 679 (June 19) (In German)

Detailed instructions are given for the use of a machine which has a built-in diamond truing device for truing the grinding wheel. A special pinion operates the wheel to bring it into contact with the diamond when necessary. *A* *Ab Cg Nj Psf*

USP 2,861,561 (May 16, 1957) **J. Olson, Norton Co**

Grinding machine truing apparatus

A transversely movable fluid actuated truing tool carrier on a longitudinally movable fluid actuated slide whose end positions are adjustable for varying the extent of plane faces generated on opposite side faces of the grinding wheel is guided by a follower on a forming bar truing a plane face and an adjacent back tapered face on opposite sides of the wheel. Fig 3 shows the arrangement of the diamonds 118 on carrier 90 supported on slide 46 in the truing apparatus mounted on the grinding wheel guard 40. Follower 105 engaging forming bar 106 adjustably mounted on slide 46 guides the truing tools along the faces of wheel 12. Rods 121, 122 and cross head 120 with springs 124 are part of a safety mechanism to move carrier 90 vertically into an uppermost position in case of failure of the fluid pressure system. (9 claims, 5 illustr). Ref cited : 2 USP.

J *Chc Pr:Nj Psf.545*

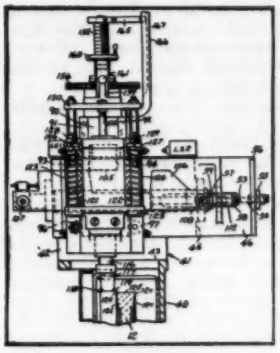

Fig 3. The truing apparatus, showing diamonds 118. USP 2,861,561.

USP 2,862,338 (Apr 12, 1957) **O. E. Hill, Norton Co**

Grinding machine

The truing apparatus is intended for a centreless grinder to true the grinding and the regulating wheel including a wear compensating mechanism for advancing the grinding wheel before each pass of the truing tool across the wheel face. A wind and unwind motion is imparted to the wheel mechanism each time it is actuated for taking up back-lash in the parts of the mechanism. Fig 4 is a fragmentary side elevation of a centreless grinder with the truing tool mechanism supported on bracket 110 urged in clockwise direction by spring 112. Two truing tools 117 and 119 are provided for the two wheels as shown in Fig 5. 60 is the work rest blade, 71 the forming bar. The mechanism is electrically controlled and fluid operated, and includes pawl and ratchet mechanisms for the wind and unwind motions and the incremental rotary motion of the feed unit. (9 claims, 14 illustr). Ref cited : 3 USP ; see also USP 2,814,159.

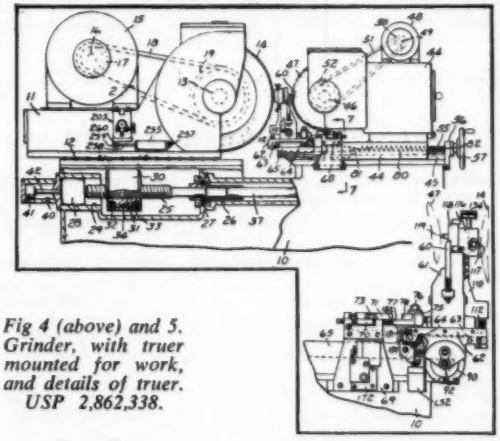

Fig 4 (above) and 5. Grinder, with truer mounted for work, and details of truer. USP 2,862,338.

J *Chcc Pr:Nj Psb.545*

USP 2,862,492 (May 27, 1955) **S. P. Bruce, A. T. Kohlstrunk, Wheel Trueing Tool Co**

Hydraulic in-feeding mechanism for diamond tools

Incremental advance of the diamond truing tool in centreless grinders has up to now necessitated a number of time-consuming movements of the operator. Manual advance of the truing tool required a position at the rear of the machine, actuation of the traversing mechanism had to be effected from the front, and these

movements had to be repeated several times during one truing operation. Further movement was required for operating the coolant valve. Despite this expensive extra work, manual advance of the truing tool can never result in a uniform truing operation as the incremental feed of the diamond will either be too great or too small. By using a hydraulic actuation system uniform advance is obtainable without any movements of the operator who remains at the stock loading station and controls the truing operation from his remote position. The main parts of the system are shown in Fig 6 and 7. Indexing mechanism 14 incrementally rotates tool 10 driven through lead screw 17 coupled to one-way clutch 30 which is oscillated by worm gear mechanism 40, 43, driven by reciprocating piston 45 in cylinder assembly 47. The incremental clockwise rotation is adjusted by stop block 19 with faces 53, 54. (6 claims, 5 illustr). Ref cited: 12 USP.

J Chc Pr:Nj Psfb.545

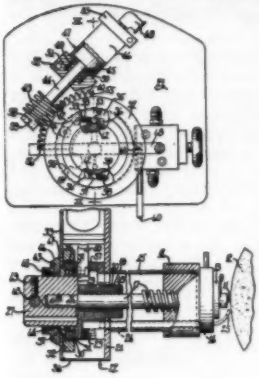

Fig 6 (top) and 7. The main parts of the system are shown in these two diagrams. USP 2,862,492.

USP 2,862,493 (May 24, 1957) **T. J. Pesce, Sculli Machine Co Inc**

Device for contouring grinding wheels

The device is mounted between the centres 35, Fig 8, of the grinding machine, and secured to a suitable part such as the way 39 by screws 40. The desired angular adjustment is obtained as shown in Fig 9 by screws 44 and clamping nuts 42. The spring loaded truing tool 23, 24, sliding along bar 7, bears against template 28 through follower 26 and is transversely fed across the face of the grinding wheel 25 by feed screw 11 rotated by worm gear 16, 17, driven by an electric motor. (4 claims, 4 illustr). Ref cited: 4 USP; 1 GP.

J Chc Pr:Ceqg Psc.545

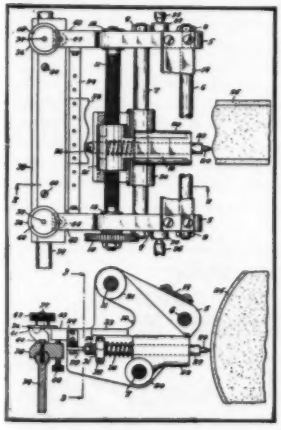

Fig 8 (top) and 9. Two views of the contouring device. USP 2,862,493.

FINE BORING AND FINE TURNING

Choosing the lubricant for carbides

J. A. Boyd (Van Straaten Chemical Co, Chicago, Ill). *Tooling & Prodn* 1959 Vol 25 (3) p 62 (June)

1 illustr. *W Pdc Sk*

Chrysler cuts aluminium with diamond tools

Chrysler Corp. *Am Machinist* 1959 Vol 103 (12) p 113 (June 15)

Diamond machining of aluminium die castings for Powerflight automatic transmissions holds dimensions within ±0.001 in., and produces finishes down to 20 microinches. The diamond tool is cemented to a steel holder, and the diamond has sharp edges to prevent build-up of aluminium chips under the tool tip. The machining operation is carried out without coolant on a two-station borer operating at 2,500 rev/min and 722 surface ft/minute. Changes to diamond tooling are being given more attention in the motor car industry: results show no tolerance troubles, higher production, reduced scrap, and lower costs. 3 illustr.

W Az Bfg Ceq Nf

Turning and boring with single-point diamond tools

J. B. Pond. *Carbide Engg* 1959 Vol 11 (6) pp 19-22 (June)

Sea-Horse outboard motor aluminium pistons are turned and bored with single-point diamond tools. Less expensive carbide and ceramic tools were tried but failed to compete. Standard tool geometry is used for rough and finish turning diamond tools, and a special geometry has been developed for the boring tools: tip radius is 0.025 in.; back rake 3°; side rake 5°; and end relief 10°. The operational set-ups are described, and diamond tool plans are given. Turning tool life averages between 1,000 and 2,400 pistons per cutting edge, after which the diamond is resharpened. Vat-Rol water-soluble coolant is used. Rough boring is carried out with carbides, finish boring with diamond. Up to 3,000 to 5,000 pistons can be bored before the diamond needs resharpening. Good finishes and close tolerances are achieved. 7 illustr.

W Agg Bfg Ceqb Nf/Agg Bfg Cfd Pdc/Aeg Bfg Cfdb Nf

Chatter in turning. Das Rattern beim Drehen

Anon. *Technica* 1959 Vol 8 (13) pp 669-674, 697-698 (In German)

The causes of chatter are analysed and the usual methods of avoiding it by such means as the firm fixing of the workpiece and careful overhaul of the machine parts are described. Different types of turning process are described in detail. (To be concl). 15 illustr.

A Ceqb Qng

New aluminium alloy produces chip swarf

Anon. *Metalworking Prodn* 1959 Vol 103 (21) p 897 (May 22)

Kynal 11S aluminium alloy contains small quantities of lead and bismuth evenly distributed throughout its structure which serve as chipbreakers. The long spiral swarf normally associated with conventional aluminium alloys is avoided. High cutting speeds can be used, and rake angles should be kept small. 2 illustr.

W Bfxc Ceq:Ceb/Bfxc Ceq Uqe

How to machine mechanite. I-III

Anon. *Metalworking Prodn* 1959 Vol 103 (21) pp 927, 929, 931 (May 22)

Recommendations on tool geometry, turning, milling, and boring speeds, and information on tool life in relation to speed, feed, and depth of cut, and on the speed-feed relationship. 6 illustr, 8 tables.

W Bfz Ceq.21

Sintered carbide tools and their economic use. Gli utensili in metallo duro e il loro impiego economico

R. Colombino. *Macchine* 1959 Vol 14 (6) pp 569-580 (June) (In Italian)

23 illustr, 5 tables. *M Pdc*

MACHINING OF STONE, ETC

DAS 1,049,189 **J. F. Barry, N. C. Seeley, Western Electric Co Inc**

(Dec 31, 1954—conv date, USA)

Application of an electrolytic method for producing a tensionless cut in a semiconductor. Anwendung eines elektrolytischen Verfahrens zur Erzeugung eines spannungsfreien Schnitts in einem Halbleiter

The method is based on the cutting of metal by a thin straight wire electrode carrying a limited current towards which the piece to be cut is fed at a uniform speed. It has been found that by this method a cut can be made in a semiconductor without producing thermal or mechanical tension. No finishing treatment is necessary and the cuts can be held very narrow so that more disks can be made from the same semiconductor body than by any previously known method. An electrolyte is used of high resistance, and the etching current is concentrated on the bottom of the cut by keeping the distance between electrode and workpiece very small. This distance should be less than double the diameter of the electrode. A solution of potassium hydroxide (0.002%) in de-ionised water is mentioned as an electrolyte, and a tungsten wire of 0.084 mm as an electrode to cut a *p*-type monocrystalline germanium rod into disks of 0.025 mm thickness. The constant current was 28 milli-amps, the feed 0.165 mm/min, and the width of the cut 0.178 mm. (1 claim, 4 illustr). Ref cited: GP 565,765; *Metallkunde* 1924; *Proceedings of the IRE* 1953.

J *Bf Ceqh.545*

ROCK DRILLING

Guide to diamond core drill tools

F. C. Sturges. *Engg & Min Journ* 1959 Vol 160 (6) p 202 (June)

A comprehensive guide to diamond core drill fittings is given in tabular form. It shows, in sequence of development, diamond drill tools that have been given letter names, along with the dimensions pertinent to their use and their current status in regard to standardization. Trends in exploratory drilling are briefly summarized. 1 table.

W *Nhe*

Diamond drill crowns

R. Zangl (Metallwerk Plansee GmbH, Reutte/Tirol). *Planseeberichte fuer Pulvermetallurgie* 1957 Vol 5 (1) pp 20-26 (Apr); *SA Min & Engg Journ* 1959 Vol 70 Pt 1 (3460) pp 1323, 1325, 1327, 1351 (June 5) (In English, original in German)

Abstr *Bibl Ind Diamond Appl* 1957 Vol 14 p B103 (June). *W* *Nhb*

Considerably larger display of machinery in the German Industries Fair, 1959. Wesentlich vergroessertes Maschinenbau-Angebot auf der Deutschen Industrie-Messe 1959

Anon. *Scmiertechnik* 1959 Vol 6 (3) pp 117-131 (May-June) (In German)

A wide range of machinery and mechanical equipment is reviewed, including a mention of diamond drill crowns for turbo-drills, manufactured by Christensen Diamond Products GmbH, Celle. These crowns have a life roughly as long as that of the turbos themselves. The drilling performance in loam is 2m/hour at a depth of about 2,500 metres. 13 illustr.

A *Nhg Uqe*

For all products and services, use . . . E&MJ's 1959 Buying Directory

Anon. *Engg & Mining Journ* 1959 Vol 160 (6) pp 266-311 (June)

Guide to manufacturers of drilling equipment, including diamond drill bits.

W *Cfb.2584.56/Nh.56*

How drilling costs are being cut in Canada

A. S. Murray, S. P. MacKay. *World Oil* 1959 Vol 148 (7) pp 106-109 (June)

4 illustr, 2 ref. *W* *Cfb.252.343*

USP 2,862,691 (Apr 3, 1956) **C. D. Cochran, Jersey Production Research Co**

Coring bit assembly

In order to secure a representative core whose fluid content is unaltered from the formation from which it is obtained, which is important when drilling for petroleum, a coring assembly is used comprising a primary coring bit and a secondary coring bit, using a primary sealing fluid and a secondary drilling fluid. The actual core is cut by a thin inner primary bit employing a viscous fluid as a cutting fluid and sealing agent. This fluid, with the aid of auger teeth, carries the cuttings to the cutting plane of the secondary outer bit where they are picked up by a conventional mud fluid and carried to the surface. The secondary bit cuts the hole to gauge size. (3 claims, 1 illustr). Ref cited: 6 USP; 1 FP.

J *Plb Qc.545*

USP 2,865,606 (Aug 13, 1956) **D. L. Farmer, Cincinnati Tool Co**

Rock drill

The cross-shaped face of the drill is (empirically) determined to reduce the tendency of carbide inserts to work loose under the influence of continuous impact blows. The chisel face is formed by two diametrically opposed supporting ribs and two such centring ribs tapering inwardly toward the centre of the drill at right angles to the supporting ribs through which a slot is milled. A single chisel carbide blade is placed in this slot and two centring inserts are placed in a second slot in the centring ribs. The chisel and centring blades and the drill body are brazed together. The chisel blade is made from a single piece of tungsten carbide and the cutting edges can readily be sharpened, the grinding wheel simultaneously sharpening the adjacent tips of the centring inserts. (1 claim, 4 illustr). Ref cited: 2 USP; 1 BP; 1 DBP.

J *Cfbf Pl.545*

WIRE DRAWING

Production problems in drilling small holes. Fertigungsprobleme fuer Kleinbohrungen

G. Barna. *Fertigungstechnik & Betrieb* 1959 Vol 9 (6) pp 325-331 (June) (In German)

The theory of fine drilling techniques in briefly examined, with regard to the relationship between drilling conditions and workpiece size. Five methods of drilling are discussed in detail: with the method commonly used up till now, with an abrasive, by plastic deformation, by electrolytic methods and chemical heat effect, and by electro-erosion. The method used for drilling drawing die diamonds is the electric or chemical heat method. In the heat method the hole through the diamond is produced with the help of acid which burns into the crystal. A V2A-steel box serves as an oven, with a double-walled quartz-

glass lining containing molybdenum heating wires. The diamond is clamped on a sintered aluminium shank projecting from the bottom of the oven. The process can be watched through quartz glass windows. The 'boring tool' is a quartz glass spray which ejects acid on to the diamond through a 0.1 to 0.35 mm diameter opening. The distance between the spray and the diamond surface to be worked is a few tenths of a mm. During the process hydrogen is brought to the diamond through a porous aluminium tube. A temperature of 900 deg C is reached after about one minute from the positioning of the diamond and the release of hydrogen, and the acid can then be released to burn the diamond.

In the electrolytic method the diamond is set in a small bowl, which is filled with just enough of the electrolyte to cover its surface. The tool is a platinum or platinum-iridium needle, which rests with a constant very light pressure on the working spot. The needle, being an electrode, is shut off from the current at one pole, while the other electrode does not actually touch the workpiece, but is dipped into the electrolyte a little way away from it. The current released to cause the erosive process to begin is usually of 60 v. 13 illustr, 10 ref, 1 table.

A *Cfbp.21/Fc Hqc Nk/Fc Hqd Nk*

USP 2,866,364 (May 8, 1953) **P. Bieberich**

Wire drawing die blank and method of making same

The diamond die blank is set inside a ring in a soft aluminium receptacle with a depression in the bottom of the receptacle for the blank, and with a thin cylindrical wall which is folded inwards and pressed downwards by a punch so as to force the metal into

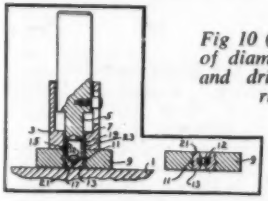

Fig 10 (left) and 11. Arrangement of diamond in intermediate stage, and drilled diamond in holding ring. USP 2,866,364.

intimate contact with the diamond and the ring holding the receptacle. Diamonds mounted in this way will seldom break during drilling and usually do not shift from their central position in the holder. The arrangement is illustrated in Fig 10. Diamond 12 is set in receptacle 13 in ring 9 under punch 5. The drilled diamond still in the holding ring 9 is shown in Fig 11. (8 claims, 4 illustr). Ref cited : 15 USP ; 2 FP.

J *Fc Hq Nkb.545*

GRINDING AND POLISHING OF HARD METALS

300,000 rpm

Ashcombe Co, York, Pa. *Am Machinist* 1959 Vol 103 (12) p 3 (June 15)

The Borden Airoter dental drill has been adapted for industrial use. The tool is $\frac{1}{8}$ in. in diameter and $\frac{1}{2}$ in. long. It operates in excess of 300,000 rev/min with carbide burrs or diamond points.

W *Nhf/Plb*

Carbide mill bores small tapers at 45,000 rpm

S. J. Kostermann. *Am Machinist* 1959 Vol 103 (12) pp 120-121 (June 15)

4 illustr. *W* *Cfd Pdc*

Why ? . . . How ? . . . Establishing standards on diamond wheel performance

F. J. Lennon (Kennametal Inc, Latrobe, Pa). *Carbide Engg* 1959 Vol 11 (6) pp 12-16 (June)

All diamond wheels in a plant should be checked through one department and assigned a serial number. When the wheel is issued to the shop it should be accompanied by a chart on which can be recorded factors relating to its performance, *eg* items ground, truings required, and wheel action. Wear of the wheel should be measured and logged periodically. When the wheel is worn out it should be returned to the issuing department, together with the chart. The chart can then be analysed and wheel performance evaluated. The standards derived from reports on wheels can be in terms of hours of life, stock removal per wheel, or a number of other variables. 4 illustr, 2 tables.

W *N.2552.263*

Duplex face grinding machine

Anon. *Machines & Tooling* 1959 Vol 30 (3) p 9 (Original in Russian)

An English set-up for grinding the parallel faces of various ball and roller races. Plunge grinding with two grinding wheels is the method used. Components are oscillated for added precision on parallelism and size. 4 illustr, 1 ref. *W* *Az Chcd Pr*

Tolerances and finishes require clean coolant

Alsop Engineering Corp, Aster St, Milldale, Ohio. *Grinding & Finishing* 1959 Vol 5 (2) pp 38-39 (June)

Sealed Disc Filters and Disc-Pak filters are built in 6, 8, and 12 in. diameters. The Sealed Disc Filter is particularly suitable for the recovery of valuable solids, *eg* diamond. Applications range from finish grinding high chrome tapered roller bearing races to diamond and crush trued piston pin grinding.

W *Fw Hw Pwc*

Rimex grinding machine for valve seats in motor car cylinder blocks

Riwosa SA, Zurich, Switzerland ; British rep : North London Metals Ltd, Machine Tool Div, 218 Mare St, London E 8. *Machinery* (London) 1959 Vol 94 (2432) pp 1379-1380 (June 24)

In use, the wheel is located centrally with the seat to be ground by a pilot bar which passes through the bores of the hollow spindle and the valve guide in the cylinder block. The unit is supported by a rod which extends through the bore of a hollow micrometer screw at the top of the body, and makes contact with the upper end of the pilot bar. Before grinding is started, the unit is adjusted for height so that the wheel just clears the seating, and is then secured to the rod by means of a grubscrew. When the spindle has been started, the unit is lowered to apply a cut to the seat by rotating the micrometer screw. Drive is taken by a flexible shaft. Interchangeable grinding wheels of different diameters, mounted on metal adapters, are provided for attachment to the spindle nose. A separate unit, provided with an adjustable diamond holder, is supplied for forming different cone angles at the nose end of the grinding wheel. 1 illustr.

W *Az Chc Pr*

Answer to synthetic diamonds

Diamond Res Lab, Johannesburg. *SA Min & Engg Journ* 1959 Vol 70 (3461) p 1379 (June 12)

A natural diamond grit, 40% more efficient than conventional diamond grits, has been developed for resin-bonded grinding wheels. A type of diamond particularly suitable for drilling purposes has also been developed. *W* *Nv Urb*

Flanges : check and double check

R. L. McKee. *Grinding & Finishing* 1959 Vol 5 (2) p 23 (June)

Advice on the use of grinding wheel flanges. 1 illustr.

W *Pz Qd*

Grinding straight-sided internal splines

M. I. Moldavskii. *Machines & Tooling* 1959 Vol 30 (3) p 36 (Original in Russian)

4 illustr. *W* *Az Chc Pr*

Tool grinding according to [S.V.] Stankevich

L. K. Petrosyan. *Machines & Tooling* 1959 Vol 30 (3) p 33 (Original in Russian)

Higher grinder productivity is achieved by grinding the cutting edge clearance angle of carbide tipped tools on the periphery of the wheel, and then on the side of the same wheel. The peripheral grinding produces a concave back face, and the face grinding produces a land. Fine lines and scratches can be removed by passing a fine file over the cutting edge, as though to blunt it. 3 illustr. *W* *Al Bkc Chc Pr*

Hard wheels burn—soft wheels lose form

A. Rakestraw. *Grinding & Finishing* 1959 Vol 5 (2) pp 19-20 (June)

Cams (1055 and 1078 steel), ground with a resinoid aluminium oxide wheel, 70 mesh, R grade, showed a burned surface when etched, and a drop in hardness. Softer wheels would not hold the form.

An increase in cam speed and a reduction in the rate of infeed is recommended. The grinding wheel should be oscillated. The truing diamond should be sharp, not rounded, and an ample supply of coolant should reach the grinding area.

W *Ab Bl Urb:Cg Nj/Az Chc Pe Rj Urb:Unh*

Threaded chasers with ground threads. Gewinderollbacken mit geschliffenem Gewinde

K. Schimz. *Werkstattstechnik* 1959 Vol 49 (6) pp 320-322 (June) (In German)

9 illustr, 4 ref. *A* *Az Chcp*

Lubricants for thread grinding. Gewindeschleifoele

H. Steinke. *Schmiertechnik* 1959 Vol 6 (3) pp 131-137 (May-June) (In German)

Although for cylindrical and flat grinding water coolants are almost exclusively used, the best results in thread and profile grinding are obtained with the use of a water-free oil lubricant. Less wear of the tool and wheel will result in economy of diamond or other truing devices. Different types of thread and profile grinding methods are described, and hints are given for obtaining the best results. 13 illustr.

A *Chcp Qr Sk*

Crushing boart

L. van Geersdaele. *Diamant* 1959 Vol 2 (12) pp 5-9 (May) (In English, Flemish, and French)

In 1956, crushing boart accounted for 55%, by weight, of total diamond production. The importance of boart was not fully appreciated until tungsten carbide became widely used and boart was required for truing purposes. The various applications of boart in different industries are enumerated, and the factors to be considered when bonding are emphasized, *eg* mesh size and concentration. 3 illustr. *W* *Fg*

LITERATURE REQUESTS

Please quote the page number of the Bibliography containing the original reference, and the author and title of the article, in all cases.

USP 2,861,400 (Nov 28, 1955) **R. G. Ellis, Micromatic Hone Corp**

Machine for grinding parallel surfaces

The machine belongs to the class of flat surface lappers of the opposed wheel type for grinding opposed faces on workpieces. Non-uniform wear of the laps requires frequent work interruptions for supplemental truing of the abrading wheels in conventional machines. By a certain arrangement of the work receiving apertures in the feed disk, for which a mathematical expression is given, annular zones of abrasion are established in the working faces of the abrading wheels, each of which does work on a different workpiece at one time and on each of the workpieces in succession. These zones will acclimate themselves to a steady state of wear so that the abrading surfaces are maintained parallel with alternate zones of slightly greater and slightly less wear without any need for supplemental truing of the abrading wheels. The workpieces produced have consistently parallel opposed faces and are of uniform size. (18 claims, 11 illustr). Ref cited : 6 USP ; 3 BP.

J *Az Chc Pe/Az Chd Pg*

NEW MACHINING METHODS

Spark electrode shape decides cutting rate

Anon. *Metalworking Prodn* 1959 Vol 103 (26) pp 1100-1101 (June 26)

2 illustr. *W* *Ceqm*

Ultrasonic machining of hard and brittle materials

L. D. Rosenberg, D. F. Yakimovich. *Vestnik Mash* 1959 Vol 39 (2) pp 51-55 (Feb) ; *Engs Digest* 1959 Vol 20 (6) pp 255-256 (June) (Original in Russian)

Russian techniques are described, and the performance, in terms of material removal and tool wear with various workpiece materials, is shown. Other variables dealt with are the grain size and its effect on accuracy and surface roughness, feed rate and feed force relationship, and feed rate—abrasive suspension viscosity relationship. Abrasives mentioned are boron carbide, silicon carbide, and corundum. 3 illustr, 2 tables.

W *Ba Ceq Rd.33*

Electron beams machine by vaporization

Carl Zeiss, West Germany. *Metalworking Prodn* 1959 Vol 103 (23) pp 986-987 (June 5)

Electron-beam equipment, originally used for welding, has now been adapted for machining purposes. A concentrated beam of electrons vaporizes the workpiece material to form holes or slots of 0.0015 in. or less. 4 illustr. *W* *Ceqn*

POWDER TECHNOLOGY

Agreement between independent methods for particle size distribution measurements on finely divided powders including phosphates

D. P. Ames, R. R. Irani, C. F. Callis. *Journ Phys Chem* 1959 Vol 63 p 531 ; *Insdoc List* 1959 Vol 6 (11) col 822 (June 1)

W *Vgf*

TOOL PRODUCTION

Nimonic 80 moulds for making diamond wheels

Triefus Industries Ltd, Manor Royal, Crawley, Sussex. *Wiggin Nickel Alloys* 1959 (44) pp 22-23

Metal-bonded diamond wheels are produced by heating metal powders and the diamond abrasive at temperatures in the region of 900 deg Centigrade. The moulds are then pressed at 10 tons/sq in.; this may be preceded by cold pressing at 30 tons/sq inch. Mild steel and tool steel moulds were unsatisfactory for this process, and moulds are now made from Nimonic 80, a high-nickel alloy developed originally for gas turbine blades. Moulds have already been used up to 50 times without showing distortion. 3 illustr.

W *Nv Qc*

USP 2,862,806 (May 2, 1955) **L. R. Nestor, Minnesota Mining Mfg Co**

Molded rotative abrasive articles and method of making

Fully uniform grinding wheels are produced by centrifuging a mixture of abrasive grains and a resinous abrasive binder in liquid form within a centrifugal mould rapidly rotating at a speed above which no change in position of the mixture will occur (1,750 rev/minute). The binder is hardened in its position in the mixture and cured by heat. Reinforcing fibres may be added to the mixture. A binder is described which consists of an epoxide resin (Bakelite BR-18774) 220 grams and metaphenylene diamine 36 grams for 80 mesh aluminium oxide grains 579 grams. (11 claims, 4 illustr). Ref cited: 7 USP.

J *Pe Urb:Qc.545*

USP 2,863,750 (Oct 18, 1954) **S. M. Booth**

Method, composition and apparatus for mechanically setting or resetting diamond particles in a working surface

A mixture of diamond particles, glass particles of larger size than the diamond particles, and a carrier such as petroleum jelly or a heavy grease is applied to the working surface of a wheel (block; stick) while rotating the wheel at a speed in excess of about 300 rev/min using a freely rotating roller under such a pressure that the glass particles cut the working surface and loosen previously set diamond particles. The roller is then further applied under such a pressure that the glass particles are crushed to a size smaller than the diamond particles which are forced into the then forming interstices in the working surface. The mesh of the diamond particles may be from 100 onwards to 1,500 for obtaining a microfinish. The mesh size of the powdered glass may be 80-120. It is said that it has been possible to renew a diamond grinding wheel in five minutes in a manner rendering it indistinguishable, as regards cutting ability, from a new wheel, without removing the wheel from its normal position of use. (7 claims, 8 illustr). Ref cited: 6 USP; *Hackh's Chem Dictionary*.

J *Km Lfd Nv.545*

USP 2,866,698 (May 13, 1953) **P. L. Kuzmick**

Diamond abrasive element

In a bonding composition for diamond wheels a metal portion (tungsten carbide 40-80%, iron 16-40%, copper 0-20%, manganese 0-4%, and graphite 0-2%), and a vitrified portion (feldspar 10-40%, kaolin 0-30%, borax glass approximately 3%, boric acid approximately 6.5%, and silicon carbide approximately 39%) are present in equal quantities. The glass is capable of wetting the diamond particles while the metal part provides a hard and strong skeletal structure inhibiting oxidation and thus permitting the use of fairly high temperatures during manufacture (2,200 deg F) without harmful effect. Diamond wheels with this kind of bond have an exceptionally long life and free cutting characteristics. (11 claims). Ref cited: 4 USP.

J *Nv Urc.545*

Swiss P 334,744 (Feb 8, 1955) **P. Hawtin, Dental Mfg Co Ltd**

Method of making a grinding tool and grinding tool made by this method. Verfahren zur Herstellung eines Schleifwerkzeuges und nach dem Verfahren hergestelltes Schleifwerkzeug

The working point or face of the (steel) tool body is covered with silver solder and heated to fluidize the solder. Copper coated tungsten carbide powder is then applied to the molten surface until it is completely covered. The high temperature is maintained until fusion is obtained between the solder, the powder, and the metal body. (2 claims).

J *Pe Qc.545*

DAS 1,049,266 (Apr 7, 1956) **W. Osenberg**

Tubular face grinding body. Rohrartiger Stirnschleifkoerper

Resin-bonded wound and compressed webs with abrasive grains embedded therein are formed into tubular bodies in which are mounted additional hollow grinding bodies of any cross section, while leaving sufficient space for chip removal. The additional grinding bodies may be concentrically arranged grinding tubes with radial ribs for connexion with the main body. Several such tubular bodies may be arranged within the main body. (3 claims, 5 illustr). Ref cited: 2 GP; 1 DBP; 1 DAS; 1 Swiss P; 1 FP; 2 BP; 2 USP.

J *Pe Urb.545*

SURFACE FINISH TESTING

The problem of measuring surface microstructure. Bemerkungen zum Problem der Messung der Oberflaechenmikrogestalt

D. Becker, G. Dornheim, H. Kortum, F. Soeldner. *Feingeraetetechnik* 1959 Vol 8 (6) pp 253-260 (June) (In German)

12 illustr, 11 ref. *A* *Cx Unf*

MISCELLANEOUS

Carbide Engineering, annual diamond issue

Hitchcock Publ Co, 222 E Willow Ave, Wheaton, Ill. *Carbide Engg* 1959 Vol 11 (6) (June)

The principal articles in the annual diamond issue are: Why? How? Establishing standards for diamond wheel performance, by F. J. Lennon; Turning and boring with single-point diamond tools, by J. B. Pond; 'M' stands for man-made, by R. L. McKee; Producing small carbide saws by electrolytic grinding; and Grinding wheel tests on cemented [sintered] carbides reveal hardness variations. Abstracts of these articles appear under the appropriate section headings of this issue of *Industrial Diamond Abstracts*.

In addition to these articles, many of the regular features are retained in *Carbide Engg*, and there is also a useful index of diamond tool manufacturers in the US.

W *N.532*

Development of the Hungarian machine tool industry. Sviluppo dell'industria ungherese delle macchine utensili

Anon. *Macchine* 1959 Vol 14 (6) pp 625, 627, 629, 631 (June) (In Italian)

5 illustr. *M* *Pr.132.329*

The world market and trade of machine tools as seen by American designers. Il mercato delle macchine utensili e commercio mondiale visti dai costruttori americani

Anon. *Macchine* 1959 Vol 14 (6) pp 633, 635 (June) (In Italian)

M *Pr.25.31*

The application of oil mist lubrication in machine tools

I. V. Mazyrin. *Machines & Tooling* 1959 Vol 30 (3) pp 39-41 (Original in Russian)

7 illustr. *W* *Pr Qr Sk*

Great Britain's small, but highly efficient and vital machine tool industry. Piccola, ma efficientissima e vitale, l'industria delle macchine utensili in Gran Bretagna

L. Rule. *Macchine* 1959 Vol 14 (6) pp 613, 615, 617 (June) (In Italian)

Mentions the development of sintered carbide and ceramic cutting tools and of electro-spark machining. 2 illustr.

M *Ceqm Pr.321/Pdc.132.321/Pdd.132.321*

The Zeiss interference microscope in praxis [practice]

M. Uhlig. *Zeiss Werkzeits* 1958 Vol 6 (30) pp 70-77 (Dec) (In English)

Covers the theory and range of the microscope, and deals in detail with direct examination of roughness and surface configurations, the lacquer replica process, enlarging the range in depth measurement by an immersion method, measuring the thickness of thin coatings, and photographing interference figures. Vickers diamond pyramid impressions can easily be analysed with the microscope, and two photographs show diamond pyramid indentations as seen under the microscope. 33 illustr, 5 ref.

W *Cvd Nde.131:Wcm/Wcm.21*

USP 2,862,795 (Dec 4, 1953) **E. C. Lowe, Norton Co**

Process of synthesizing silicon carbide

A pelletised mixture of silicon and coke, both in the solid phase, are heated to a reaction temperature (1,550 deg C) below the melting point of silica for at least two hours. Some carbon of the coke removes the oxygen of the silica and the resulting silicon combines with more carbon of the coke to form silicon carbide of cubic crystallinity in a solid phase reaction. A furnace according to USP 2,125,588 (Ridgway) may be used. (8 claims, 3 illustr). Ref cited: 5 USP; Mellor "Comprehensive Treatise, etc".

J *Rl:Qc.545*

DAS 1,049,107 **K. Ruthardt**

(May 22, 1951—conv date, Italy; Aug 7, 1951—conv date, USA)

Sintered hard metal alloys. Gesinterte Hartmetall-legierungen

It has been found that the addition of beryllium oxide and/or zirconium oxide greatly improves the wear resistance and the tool life of the usual alloys containing compositions of tungsten carbide. The amount to be added should be 0.1 to 1.5% beryllium oxide and/or zirconium oxide besides 3 to 15% metals of the group including iron, in particular 3 to 13% cobalt, while the remainder would be tungsten carbide, 30% of which may be replaced by titanium carbide. Up to 2% of the composition may contain one or more of the metals copper, silver, gold. (3 claims). Ref cited: 1 GP; 1 Austrian P; 2 Swiss P; 1 USP.

J *Bfy Cql.545*

PUBLICATIONS RECEIVED

BOOK REVIEW

Crushing and grinding—a bibliography

Department of Scientific and Industrial Research, HM Stationery Office. 1958, 425 pp, illustr, tables, indices. Price: 35s 0d

This carefully compiled publication presents 2,800 references and abstracts relating to industrial crushing and grinding. The abstracts are prefaced by short articles on, *eg* Methods of particle size analysis, Industrial grinding, and Crushing and grinding of minerals. The indexes are simple and clear, and a minimum of cross-references in the text produces an uncluttered result which is hard to achieve in bibliographies. The section on diamond contains no references later than 1954, but the references given are comprehensive within the scope of the subject.

W *Bc Chc.55/Bc Cl.55/Chc.55/N.55/Vgf.55*

TRADE LITERATURE

'Air Tumbler' Bulletin 700

Acme Ventilating Ltd, Acme Chambers, Bradford St, Walsall, Staffs. 12 pp, 8¼ × 10½ in., illustr

Air Tumblers are wet dynamic dust collectors which separate the dust from the air by centrifugal action, while water traps and holds the dust. Various types and sizes are available—mainly large ones. They are suitable for grinding and other workshop applications.

W *Pw.57*

Diamonds for industry. Diamants pour l'industrie

Adler, 102 Faubourg Saint-Denis, Paris 10e. 4 pp, 6¼ × 9½ in., illustr (In French)

Diamond tools for truing wheels, shaped diamond tools for finishing non-ferrous metals and other abrasive or insulating materials, and diamond-impregnated wheels are briefly described. Specifications are given for size and use. *A* *N.57*

Collected catalogues

The Dumore Co, Racine, Wisc; British Rep: Automation Ltd, Devonshire House, Vicarage Crescent, London SW 11

A drill for producing holes down to 0.001 in. diameter (spade drills) or 0.006 in. diameter (wire drills) has three collets which accommodate pivot drills with shanks of 0.030, 0.040, and 0.061 inch. Two-way table travel is provided, and the top speed of the motor is 17,000 rev/minute. A 10× viewer provides clear vision during drilling.

Also available are a number of precision hand grinders and drill grinding fixtures. *W* *Pl.57*

Fulmer honing machines

C. Allen Fulmer Co, 1211 First National Bank Bldg, Cincinnati 2, Ohio. 16 pp, 8½ × 11 in., illustr

A surface finish between 1 and 100 micro-in. rms can be produced by Fulmer honing machines, depending on the grit of the stone used. Stock removal rates as high as 3 cub in./min have been achieved on some bores. Typical applications are cylinder blocks, connecting rods, valves, et cetera. This catalogue describes several models in detail, and includes a table of specifications for each model. *W Chh Pr.57*

CP mining equipment, catalogue No 55

Consolidated Pneumatic Tool Co Ltd, 232 Dawes Rd, London SW 6. 34 pp, 8½ × 11¼ in., illustr

A very wide range of mining equipment is illustrated in the catalogue, ranging from drilling and bolting equipment to chain saws and maintenance tools. Of particular interest is the CP-55 diamond drill which is rated at 500 ft with EX fittings (1½ in. diameter hole). Full specifications are given.
W Cb.2584.57/Nh.57

PATENT LISTS

BRITISH

The Official Journal (Patents) 1959 (3667) (May 27)

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